THE WEEK'S EVENTS

Buchanan Dam Lowered Flood a Foot

Investigator says empty reservoir would have reduced Colorado River height by three feet

Operation of the Buchanan Dam of the lower Colorado River Authority of Texas did not, as local residents claim, contribute to the height of the recent flood in the Colorado River, it was reported by Harry W. Bashore, investigating the flood for PWA Administrator Ickes. Bashore, an engineer with 32 years of service in the Bureau of Reclamation, said in a preliminary report, that operation of the dam reduced the flood at Austin by one foot.

Three-foot lowering

If the Buchanan Dam gates had been opened two days earlier. Bashore said, it would have reduced the flood depth by two feet, and if the reservoir had been emptied to the floor of the lowest battery of spillway gates, the flood level would have been reduced by three feet, leaving an eight-foot flood.

"While better preparation should have been made for emergency operation of the Buchanan Dam, it is doubtful if any careful forethought would have had much effect in reducing the damage caused by a flood having a peak flow and volume as great as that of July, 1938," Bashore reported.

Other dams ineffective

The Inks Dam, now completed, and the Marshall Ford low dam, now under construction, both the property of the lower Colorado River Authority, had no effect on the flood, according to Bashore. The completed Marshall Ford low dam would have reduced the flood depth at Austin about 4 ft., and the high dam would have prevented a flood.

MAJOR NEWS

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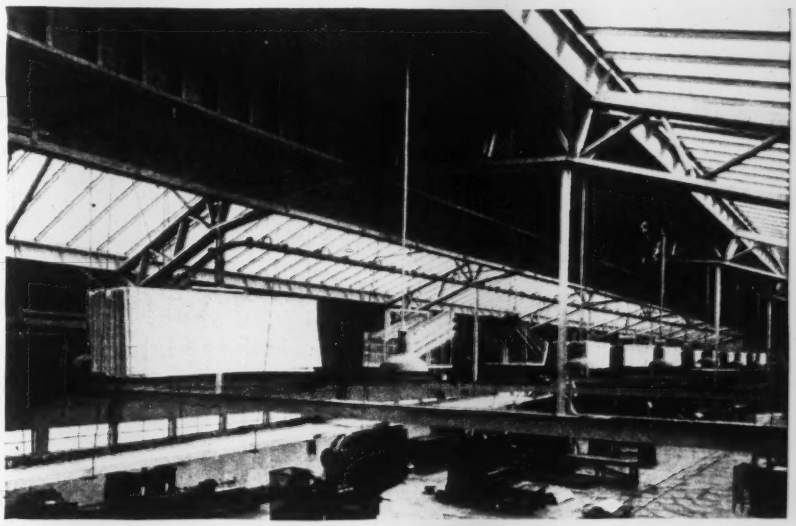

PRESSED STEEL SHEET FRAMING IN ENGLISH FACTORY

ALL STRUCTURAL MEMBERS, walls, and roof, in the new factory of the English firm, Steel Ceilings Ltd., are built up of welded copper-bearing pressed-steel sheet material in $\frac{1}{8}$ and $\frac{1}{16}$-in. thicknesses. The sheet is pressed to proper shape and welded to form the various members. These include arched roof trusses of 60-ft. span, and roof plate girders of 30-ft. span.

Columns are 8x8-in. plate boxes reinforced with vertical rods in the corners and filled with concrete. Walls and roof are formed of two layers of ribbed dovetail sheets separated by channel spacers. This type of construction on the roof eliminates purlins.

The factory is made up of five bays, 60 ft. wide by 240 ft. long, each bay covered with an arched roof. The 28 interior columns occupy a gross area of only 12 sq.ft. The accompanying illustration is taken looking down one of the 60-ft. bays.

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Chicago Filter Grant Details Announced

The City of Chicago has been informed of the detailed terms under which PWA will grant $5,416,000 to start work on the South Side filtration plant.

The preliminary $12,000,000 program will consist of a breakwater, mixing and settling basins, tunnel, and the metering of 49,000 homes. Completion of the plant will involve expenditure of another $9,000,000 on the superstructure, filter building, reservoir, low head pumps, and a chemical house.

Bids will be asked shortly by the city on a 2,700-ft. breakwater and a cofferdam. Filling in of a lake area with sand will be started this fall. The breakwater is expected to cost $713,700, the cofferdam $718,000, and the fill $1,260,000.

A delivery tunnel connecting the plant to the existing south side tunnel is expected to cost $2,840,000. Metering of homes is to start in the spring of 1939, at a cost of about $1,860,000. The city promises PWA to complete the metering within five months.

Dewatering Dropped At Niagara Plant

Operation of screens with coal-mat filters also changed at the new sewage treatment works

The centrifugal dewatering machines at the new Niagara Falls sewage disposal plant, now approaching completion, are to be removed, because they have failed to meet the specified capacity. Watson & Streander, engineers on the project, state that no decision has been reached as to what method of dewatering will be used instead. The incinerators at the plant have shown ability to evaporate a larger quantity of moisture than was at first expected and it is planned to try operating the plant without dewatering apparatus.

The original specifications for the dewatering machines were based on experiments made in Germany. According to the engineers, the contractor was allowed to substitute a standard-model American centrifuge upon his assurance that it would meet the specifications. In tests, however, it was found that, whereas the specifications called for a capacity which would have held dewatering costs to $6,000-$7,000 per year, dewatering with the centrifuges which were installed would cost $22,000-$24,000. The contractor has therefore been ordered to remove the machines.

Coal-mat filters

It has also been found necessary to change somewhat the operation of the coal-mat covered screens. Originally the screens were to have been operated with a 1- to 3-in. mat of fine coal, which was to have acted as a coarse filter. Experiments showed that the large quantity of very fine solids in the sewage tended to clog this mat and reduce capacity unduly. Experiments were made with a ¼-in coal-mat, but it was found that in this case the quantity of solids removed was unsatisfactory and clogging still occurred. The engineers state that the large quantity of fines in the sewage arises from its predominantly industrial origin.

The engineers state that they have been able to operate the filters successfully by using a ¼- to ⅜-in. mat of fine coke, the entire mat being removed at each rotation of the circular filter. With this type of mat, tests have shown a capacity of 13 m.g.d. per screen as compared with the specified 8 to 10 m.g.d. At the same time better than the 30 per cent solids-removal specified is being obtained.

Because of the difficulties in getting the coal-mat filters in satisfactory operation, the manufacturer of the screens retained George B. Gascoigne in a consulting capacity to make tests on them.

The Niagara Falls plant is a partial treatment plant. As described on p. 197 of this issue, sewage is passed through 1-in. bar screens, mechanically-cleaned grit chambers, screens with coal-mat filters, and chlorination tanks. Solids collected on the screens, including any of the coal removed, were to have been dewatered and passed to two 80-ton multiple-hearth furnaces.

Work on the plant is behind schedule, the contract providing for completion last May. It is now expected that mechanical tests will be completed by the end of this month. The contractor is permitted to submit the plant to its 30-day operating test at any time within three months thereafter.

In a statement to *Engineering News-Record* concerning operating costs Mr. Stuart Otto, president of the American Centrifugal Corp., which supplied the machines at Niagara Falls, said:

"We do not know what electric rates are used for the cost determinations mentioned. We are dewatering screenings with a power consumption of 40 kw. per hr. per machine, giving a yield as high as 800 dry lb. per hr. By the addition of coal as prescribed for the Niagara Falls plant this yield could be quadrupled.

"On account of the unsatisfactory design of auxiliary equipment not supplied by us it is impossible for us to make any tests whatsoever that would give us any definite idea of yield per hour per machine and consequent cost of operation."

WEIR IS HONORED

In recognition of his eight years service as secretary and treasurer of the Southeastern Section of the American Water Works Association, W. H. Weir was recently presented with a silver pitcher. The presentation was made by Herman F. Weideman, Atlanta engineer, on the grounds of the state capitol at Atlanta. Weir retired from his office in the Southeastern Section last April.

In his capaciy of assistant sanitary engineer of the Georgia State Board of Health, Weir has been active in promoting better design and operation of water treatment and sewage disposal work and was instrumental in organizing the Georgia water works and sewage operators school.

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Arkansas Town Ordered To Improve Sewage Plant

The City of Rogers, Ark., has been ordered to provide an adequate sewage disposal plant in order to correct conditions which resulted in a suit against the city by nearby residents, who complained of improper functioning of the plant. The order followed receipt of a report from chief engineer F. L. McDonald of the Arkansas health department that the present disposal plant is inadequate. Last month, the court ordered Rogers to improve the operation of the plant. (*ENR*, July 14, 1938, p. 39).

The court also continued a temporary order restraining the city from cutting off service from a large vinegar plant. City officials had held that the waste from the vinegar plant was responsible for improper functioning of the sewage disposal system, but McDonald said that this waste did not appear to have any effect. The court ruled that the vinegar company has a right to any volume of service required for its business as long as its wastes do not destroy the efficiency of the disposal plant.

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Compensation Law Change Planned in Pennsylvania

The Pennsylvania state workmen's compensation act would be amended to impose a presumption of negligence upon employers in court actions brought to recovery damages for injury or death under the terms of a bill which has passed the State House of Representatives.

Declarations made by the injured employee within twelve hours after the injury would be admitted as evidence under the proposed bill. If a jury found that the employee's injury was caused by the employer's violation or failure to observe any safety law or regulation, the injured employee or his dependents would be entitled to double damages.

Trade Commission Acts On Misleading Ads

The Specialty Paint Co. of Wawatosa, Wis., entered into a stipulation Aug. 16 with the Federal Trade Commission to stop representing that Rusticon Primer Surfacer, when applied to metal surfaces, will inhibit rust or further deterioration of rusty metal or make impossible the reappearance of rust on such surfaces.

The commission announced Aug. 15 that it has issued a complaint against E. L. Bruce Co. of Memphis, charging unfair competition in connection with the sale of Terminix, a compound manufactured for use in treating lumber in buildings attacked by termites.

The commission charges that the Bruce company made false and misleading representations to the effect that the use of Terminix is the only method of termite insulation, the only nation-wide bonded insulation, and the only national and the world's largest and oldest termite control group.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week total $44,479,000, an increase of 3 per cent over the volume for the corresponding 1937 week, but a decrease of 42 per cent from the high volume of a week ago.

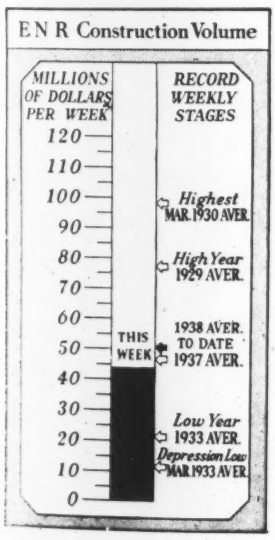
The current week's total brings the 1938 cumulative construction volume to $1,656,628,000, a 1.1 per cent gain over the $1,638,159,000 reported for the 33-week period in 1937.

Public construction is 53 per cent above a year ago, but 35 per cent below last week, while private awards are 59 and 60 per cent lower, respectively, than last year and last week.

Sewerage, bridges, commercial buildings, and large-scale housing, earthwork and drainage, streets and roads, and unclassified construction report gains over the 1937 week, and sewerage, bridges, public buildings, and streets and roads are above their respective totals of the preceding week.

New capital for construction purposes for the week totals $55,395,000, and includes $34,444,000 in PWA allotments for non-federal projects, $13,716,000 in corporate security issues, and $7,235,000 in state and municipal bonds.

New construction financing for the year to date, $2,692,612,000, is 115 per cent above the volume for the corresponding period a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending Aug. 19 1937	Aug. 11 1938	Aug. 18 1938
Federal	$2,247	$9,739	$7,607
State & Municipal	21,432	46,354	28,755
Total public	$23,679	$56,093	$36,362
Total private	19,662	20,338	8,117
TOTALS	$43,341	$76,431	$44,479
Cumulative			
1938	(33 weeks)		$1,656,628
1937	(33 weeks)		$1,638,159

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 33 Wk.	1938 33 Wk.
NON-FEDERAL	$992,102	$1,548,670
State & Mun. bonds	359,801	368,945
Corporate securities	390,327	255,959
PWA loans, grants	12,035	459,218
RFC loans	29,939	96,891
U.S.H.A. loans		154,528
K.E.A. loans		11,629
Federal Aid-Highways	200,000	201,500
FEDERAL	$261,057	$1,143,942
TOTAL CAPITAL	$1,253,159	$2,692,612

FHA MORTGAGES

	Cumulative 1937 32 Wk.	1938 32 Wk.
Mortg. selected for appraisal	$405,486	$594,422

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Aug.	232.39	111.71
Building Cost	Aug.	194.49	105.14
Volume	July	207	91

LABOR NOTES

PAINTERS in New York City will not seek wage increases this Fall. District Council 9 of the Brotherhood of Painters, Decorators and Paper Hangers, AFL, has notified the association of Master Painters and Decorators that it wishes to renew without change the contract which expires on Aug. 25. The existing contract incorporates a 5-day, 35-hour week, and wages of $10.50 per day, which were won by a strike last Fall.

ST. LOUIS electricians, however, are seeking a wage increase from $1.10 to $1.50 an hour for Class B wiremen. Wages of Class A wiremen would remain at $1.50, and of inside workers doing assembling in factories at $1.12½. Union officers have been voted authority to call a strike if demands are not met.

FORMATION of a state building trades employers association in Pennsylvania was urged at a recent meeting in Harrisburg of contractors and union representatives. Union delegates expressed the belief that such an organization would benefit both employers and workers and urged that arbitration committees be set up representing both the employers association and the union to negotiate grievances.

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Western Highway Men Meet at Reno

The seventeenth annual convention of the Western Association of State Highway Officials, held in Reno, Nev., August 10–13, was highly successful by reason of a representative attendance from eleven western states and Texas and a general participation in discussions of common problems. High lights of the meeting were a paper by Dr. L. I. Hewes, deputy chief engineer, U.S. Bureau of Public Roads on "Progress" and agreement of those present on uniform rules for maximum width, length, height, and wheel loadings for motor vehicles. A comprehensive outline of proceedings and activities of the convention will be published in next week's issue.

Officers elected for the ensuing year were: president, Chas. D. Vail, Colorado; vice president, J. H. Stemmer, Idaho; secretary-treasurer, Geo. T. McCoy, California. Members of the executive committee: L. I. Hewes; R. L. Bobbitt, Texas; R. H. Baldock, Oregon; H. S. Reed, Arizona; and R. A. Allen, Nevada. San Francisco was chosen for the annual meeting place in 1939.

Three-Lane Roads Held Valuable

National Institute for Traffic Safety Training meets at University of Michigan

There is still a place in modern highway design for the three-lane highway, V. B. Steinbaugh, deputy commissioner, and chief engineer of the Michigan State Highway Department told students of the National Institute for Traffic Safety Training, now in progress at the University of Michigan.

Steinbaugh pointed out that rural trunk lines in Michigan have produced an increasing share of the state's fatalities, rising from 27 per cent in 1924 to 40 per cent in 1936. He said that in 1936 there were only 1.32 accidents per million vehicle miles on the three-lane highways studied, compared to 1.97 on two-lane highways, and 1.81 on four-lane undivided roads.

The three-lane road must, however, he said, be so laid out that there may be an easy and economical transition to a divided four-lane road, the design which has proved safest of all highways.

Steinbaugh spoke at an afternoon session, devoted to the road as a factor in traffic safety. The program of the institute was divided into two sections. During the morning, students attended intensive technical sessions, and the afternoons were given over to general meetings, such as that at which Steinbaugh spoke, intended to acquaint safety workers with the latest developments in fields adjacent to their own.

The technical course in traffic engineering was taught by Maxwell Halsey, assistant director of the Yale University Bureau for Street Traffic Research. The first week of this course dealt with the analysis and study of high accident frequency intersections, volume counts, and speed and delay studies. In the second week traffic equipment, signs, signals, markings, and islands were covered.

Both weeks included field investigations and study problems. Each student was required to bring a map of a high accident intersection in his jurisdiction, showing all physical conditions, and detailed reports of each accident occurring at that intersection during the past year. With very few exceptions, enrollment was limited to full time employees of state or municipal governments responsible for traffic engineering.

Other technical courses were as follows: R. L. Forney, chief statistician, National Safety Council, Traffic Accident Reports and Records; F. R. Noffsinger, educational consultant, American Automobile Association, Traffic Safety Education in Elementary and Secondary Schools; Paul F. Stricker, director of field service, National Safety Council, Safety Organization and Public Education; Ray Ashworth, associate director, Northwestern University Traffic Safety Institute, Training Investigators in Accident Prevention Bureaus; and J. S. Baker, traffic safety consultant, National Safety Council, Drivers' License Administration.

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Detroit Housing Project Leased to Local Body

Two large low-rent housing projects in Detroit were leased Aug. 11 to the Detroit Housing Commission by the U. S. Housing Authority. The tenants will begin moving into the project Sept. 15, according to present plans.

The lease stipulates a schedule of rents in which the cost of shelter alone averages $5.07 per room per month for Parkside, a $4,500,000 project housing 775 white families. Rental stipulated for Brewster, a $5,200,000 project for negroes averages $4.52 per room per month on 701 dwellings.

Both projects were built by the old Housing Division of the PWA and transferred to the U. S. Authority upon the formation of that body.

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Slight Gain Shown In Urban Dwellings

More than 120,000 dwelling units in urban areas of the United States were provided in buildings for which permits were issued during the first half of 1938, according to estimates of the Bureau of Labor Statistics, it was announced Aug. 13. This figure represents a rise of 0.6 per cent over the number of units provided in the first half of 1937. The rise, however, took place almost exclusively in New York City, where a new building code went into effect in January. Excluding permits issued in New York City, the remaining urban territory showed a decline of 9 per cent.

The increase was concentrated also in multi-family dwellings, this type of structure showing an increase of 16.5 per cent over the preceding year while one- and two-family dwellings decreased 5.4 and 2.7 per cent respectively.

The largest number of permits was in the Middle Atlantic region where 41,270 new dwelling units received permits. The second largest region, the South Atlantic, trailed with 14,024. New York State, with 34,600 new dwelling units, provided more new family accommodations than any other. California with 18,500 and Texas with 9,100 ranked next.

Power Plant Planned On Colorado

State agency asks preliminary permit on 1,100,000-hp. project 80 miles above Boulder Dam

The Colorado River Commission of Arizona has applied to the Federal Power Commission on behalf of the state for a preliminary permit for a proposed 1,1000,000-hp. hydroelectric project on the Colorado River. The project would be located at the Bridge Canyon Dam site, about 80 miles upstream in a direct line from Boulder Dam, but considerably farther as the river runs.

The Colorado River Commission has asked for a preliminary 24-month permit to secure priority of application while it obtains data on which to base an application for a license. The commission has applied for a PWA grant to aid in financing the $165,000 cost of the preliminary investigation. Estimates of the cost of the completed project are not included in the application.

The proposed project consists of a dam across the Colorado River raising the water level 570 ft. and creating a lake 78 miles long, with a storage capacity of about 2,500,000 acre-feet. It is proposed to install a power plant with a capacity of 800,000 hp. with provision for installation of 300,000 additional horsepower with development of upstream storage.

Market for power

The application states that power from the proposed project could be used to develop the natural resources of northeastern Arizona and southwestern Utah. Electrification of the Santa Fe R.R. is also considered as a possible market, as is the development of rich agricultural lands underlaid with shallow water within a 200 mile radius of the proposed plant.

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Road Engineer in Ohio Appeals Dismissal

Thomas O. Snyder has made an appeal to the Ohio state civil service board from his dismissal last month, from the post of assistant engineer to the state highway department. A hearing has been set for August 26.

Highway director Jaster's dismissal order said that Snyder violated the state civil service laws by filing his candidacy for Columbiana County engineer. Snyder was appointed to his post in the highway department in 1927.

Joseph J. Rhoads Of Penn R. R. Dies

Christie of Chicago firm dies in Mobile—Lawson was builder of international bridge

Joseph J. Rhoads, who retired last May from a post as assistant to the general superintendent of the Northern Division of the Pennsylvania R. R. died August 11 at Franklin, Pa. at the age of 69. At the time of his retirement, Rhoads had been in the service of the Pennsylvania for 49 years.

A year after his graduation from Swarthmore College in 1888, he became a rodman for the Pennsylvania. Four years later he was promoted to assistant division superintendent and became division supervisor during 1899. In 1905 Rhoads was promoted to division engineer and was later made superintendent of the central division, serving in that capacity on various divisions of the Pennsylvania.

GEORGE B. CHRISTIE, a member of the engineering and construction firm of Christie and Lowe of Chicago and New Orleans, died August 1, at the age of 76. Christie spent two years at the University of Illinois, and then, in 1881, became a transitman on the St. Louis, Ft. Scott and Wichita Railroad. After several years with various railroads in the middle west, he became assistant city engineer of Omaha, leaving that post in 1888 to join the firm of Rosewater and Christie, which designed and supervised numerous sewerage plants in Nebraska and Kansas. He joined the firm of Christie and Lowe in 1888. The firm was active for many years in Chicago and the Mississippi Valley, having worked on the building of the Chicago Drainage Canal, Mississippi Levees and many other structures.

JAMES LAWSON, a civil engineer who practiced in the United States and Canada died August 10 in Fort Erie, Ont. Lawson was engineer in charge of construction of the international railway bridge over the Black Rock Ship Canal near Buffalo 30 years ago, and during the war supervised construction of docks at Charleston, S. C., for the War Department.

EDWARD O. HOWARD, 68, for 35 years a member of the city engineering department, Buffalo, N. Y., died there August 11.

SIDNEY LOVELL, for many years a partner in the Chicago architectural and engineering firm of Lovell and Lovell died in Chicago on July 6 at the age of 71.

E. W. PARR, 43, Denver civil engineer, died August 1.

WM. GRAY, a retired civil engineer of Rhinbeck, N. Y. died at Atlantic City, N. J., August 14 at the age of 78.

ARTHUR W. ARMSTRONG, 53, president of the Wood Preserving Corp., and active for many years in the Wood Preservers Association, died August 6 in Chicago.

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Queens Tunnel Face Is Regained

The contractors on the Queens Midtown Tunnel under the East River in New York City have regained the face which was lost when the tunnel was flooded during a fire June 26 (*ENR*, June 30, p. 889).

Although the lower part of the shield is still under water, it has been determined that the fire started in hay stored on the grouting platform about 50 ft. back from the shield. The fire spread in timbers as far forward as the breast boarding and the face strutting. No serious structural damage appears to have been done to the shield and few major timbers were destroyed.

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Ogden Power Bonds Voted Down

A contract between the city of Ogden, Utah, and A. C. Todd to build a municipal power plant and distribution system was upheld last May by the State Supreme Court but has now been voted down by the city electorate.

The city entered a contract with Todd in 1936 under which Todd was to build a power plant and distribution system and to take payment in $2,600,000 of special revenue bonds to be liquidated from the earnings of the plant. Attempts by the Utah Power & Light Co. and the Intermountain Branch of the Associated General Contractors to attack the project in the courts led to a state supreme court decision that revenue bonds might be issued outside the city debt limit and that competitive bidding is not required for construction contracts on projects financed by revenue bonds. (*ENR*, June 2, 1938, p. 1001)

The state law, however, requires that issuance of revenue bonds be approved by referendum election, and when the election was held Aug. 8 voters disapproved the project. A citizens committee had carried on a spirited campaign against the project based mainly on the contention that the Todd contract was loosely drawn and was awarded without competitive bidding.

Bids Are Opened On Hansen Dam

Atkinson is low bidder by large margin on flood control structure in California

Bidding about $3,000,000 below the engineer's estimate, Guy Atkinson Corp. of San Francisco was low on the construction of Hansen Dam, first major project to be constructed in Los Angeles County under the new flood control appropriation, recently made by Congress. Atkinson's bid of $5,688,000, opened Aug. 8, was nearly $770,000 less than the second lowest proposal. The district engineer has recommended that the bid be accepted.

Hansen Dam is designed as an earthfill structure with a main crest length of 9,050 ft. and a maximum height of 110 ft. The dam will have a crest width of 30 ft. and a maximum toe width of 1,000 ft. The rock-paved upstream face will be on a 3 to 1 slope and the slope of the unpaved downstream face will vary from 3 to 1 to 6 to 1. About 13,300,000 cu.yd. of earth will be handled in construction of the dam. Bed rock is 100 to 200 ft. below stream bed, and no effort will be made to reach it.

The maximum storage in the basin will be 57,000 acre feet, and a constant outflow of 3,200 acre feet will be maintained by means of four regulating gates and two open outlets 21 ft. higher. A spillway, 46 ft. above the outlet, is to be of slab and buttress type. It is not expected that this spillway will ever be used unless the record flood flow of 32,400 second feet observed last March is substantially exceeded.

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Bridge Insurance Opposed In Montana

Acting at the request of Montana state highway commissioner John M. Wheeler, a district court has temporarily enjoined the board of examiners from purchasing $12,000,000 of insurance for three years on state-owned bridges, at a cost of $120,000.

The proposed insurance would cover fire, lightning, water, ice, collision, explosion, strikes, riots, malicious mischief, tornado, earthquake and collapse damage, with a $500 deductible clause, It covers damage only to state bridges.

Governor Ayers protested the purchase of the insurance, declaring that many bridges are owned by cities and counties rather than the state, that the $500 deductible clause would eliminate recovery on most smaller bridges, and that the hazards insured by the policy had cost the state only $9,700, in the past three years.

Funds Running Out For TVA Probe

Committee studies details of Berry marble lands agreement made by TVA board

Lack of funds seems likely to postpone further investigation of the Tennessee Valley Authority from Sept. 1 until "after election", which probably means until after Congress reconvenes in January, Chairman Vic Donahey of the special congressional committee now probing TVA admitted this week. It is possible that the $50,000 allowed the committee by Congress will be spent before private utility executives get a chance to testify.

Meanwhile the special investigators employed, with the committee's permission, by Senator Davis will continue their work, as they are being paid by unnamed friends of the Republican senator, and hence constitute no drain on the committee's funds.

Nearly two weeks has been spent by the committee seeking details of the Berry marble case. The most spectacular development was the existence in the files of two reports by Edwin C. Eckel, chief geologist of TVA, dating back to November, 1934, insisting that the claims made by George L. Berry, then active in New Deal and labor circles but not at that time a senator, were worthless, and recommending that the case be taken up with President Roosevelt and Secretary Ickes.

Not only did the Eckel's memoranda charge that the deposits were worthless, but he alleged influence had been used to get government agencies to specify this particular type of marble for government buildings, thus establishing a presumable market value for the marble about to be submerged under the lake to be formed by Norris dam.

"Under the circumstances," Eckels wrote, "I most strongly recommend that the presumed facts, above stated, be checked over carefully with our legal department. If they are as stated, I would then suggest that the matter be taken up at Washington with the President and Secretary Ickes."

Subsequent to this, and one other warning memorandum by Eckels, the majority of TVA, David E. Lilienthal and Harcourt A. Morgan, it was testified, entered into a conciliation agreement with Berry. The date of the first agreement authorized was July 10, 1936, at which time, it was brought out, Berry was very active in the presidential campaign, heading a labor organization working for Roosevelt.

Testimony that Lilienthal said he did not want to "get involved" in the Berry claim, but that he did not see how he could refuse to see Berry, was given the committee by John I. Synder, director of the TVA land acquisition division.

Evans Dunn, assistant general counsel of TVA, admitted under questions by Representative Wolverton, of New Jersey, that the conciliation agreement with Berry entered into by Lilienthal and H. A. Morgan over the protests of Arthur E. Morgan was a departure from regular procedure.

Dunn defended the agreement, however, and defended the prosecution of the case, insisting that the reason the element of alleged bad faith on Berry's part was not injected until the last few weeks—just before the trial before a three man condemnation board—was that until then he only had the suspicions voiced by Eckels that there was any bad faith. He admitted that all the TVA geologists and all consultants called in had insisted the marble claim was worthless.

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No Help to Local Bidders At Tacoma

Discrimination against outside bidders on contracts of the city of Tacoma, Wash., would be illegal, according to an opinion by the corporation counsel. The opinion was based on an ordinance introduced by the mayor which would have offered Tacoma bidders a 5 per cent preference over outside bidders.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN PUBLIC WORKS ASSOCIATION, annual meeting, New York City, Oct. 3-5.

NATIONAL SAFETY COUNCIL, annual congress, Stevens Hotel, Chicago, Oct. 10-14.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, French Lick Springs, Ind., Oct. 10-14.

NATIONAL RECLAMATION ASSOCIATION, annual meeting, Reno, Nev., Oct. 11-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Rochester, N. Y., Oct. 12-14.

AMERICAN WELDING SOCIETY annual meeting, Book-Cadillac Hotel, Detroit, October 16-21.

MONTANA NATIONAL BITUMINOUS CONGRESS, Edgewater Gulf Hotel, Biloxi, Miss., Oct. 17-20.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, [illegible], October 17-18

AMERICAN RAILWAY [illegible] AND BUILDING ASSOCIATION, annual meeting, Hotel Stephens, Chicago, October 18-20.

CANADIAN INSTITUTE OF [illegible] AND SANITATION, annual convention, Royal York Hotel, Toronto, October [illegible]-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Kansas City, October 25-28.

LOCAL AND REGIONAL

AMERICAN WATER WORKS ASSOCIATION, local section meetings scheduled: New York, Poughkeepsie, Sept. 22-23. Wisconsin, in Milwaukee, Oct. 10-12. Four States, Washington, October 6-7. South West, Oklahoma City, Oct. 17-20. New Jersey, Asbury Park, Oct. 21-22.

CALIFORNIA SEWAGE WORKS ASSOCIATION, joint meeting with California League of Municipalities, Santa Barbara, September 6-7.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, Regional Conference on Surveying and Mapping, University of Louisville, Louisville, Ky., Sept. 5-8.

WESTERN SAFETY CONFERENCE, annual meeting, Los Angeles, Sept. 12-15.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Hotel Statler, Boston, Sept. 13-16.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, and New York Sewage Works Association, joint meeting, Hotel Bond, Harrisburg, Oct. 6-8.

MICHIGAN ASSOCIATION OF ROAD COMMISSIONERS AND ENGINEERS, Michigan State College, East Lansing, Oct. 25-27.

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Examinations

IOWA examinations for professional engineering, Sept. 13-14, in the Senate Chamber at the State House, Des Moines.

• • •

Short Course

A COURSE for operators of water and sewage treatment plants will be held at the University of Maryland, College Park, Md., Sept. 13-15. The course will be given in cooperation with the Maryland-Delaware Water and Sewerage Association, the Maryland State Department of Health, and the American Water Works Association, Four States Section. Advanced work will be provided for those who have attended previous courses.

PERSONAL

IRVING C. HARRIS, consulting engineer, who has been with the Bureau of Reclamation since 1933, in charge of inspection and installation of equipment at Boulder Dam, has been appointed director of power there. A graduate of California Institute of Technology, Harris served as chairman of the engineering jury that investigated the St. Francis Dam failure and was a member of a similar group that determined building damage resulting from the Southern California earthquake in 1932. He is 60 years old.

CECIL J. ESPY, JR., of the U. S. Geological Survey at Boise, Idaho, has been appointed as assistant civil engineer in the U. S. navy with the rank of Lieutenant, Junior Grade, from an eligible list established as a result of an examination held in 1936. Espy will be assigned to duty at the Puget Sound Navy Yard.

CARL A. ERICKSON of Chicago has also been commissioned as an assistant civil engineer in the navy with the rank of Lieutenant, Junior Grade, from the same eligible list. He will be assigned to the U. S. Naval Academy at Annapolis.

JAMES A. BRAKES has resigned the post of city engineer of Lima, Ohio, which he held for nearly five years. He gave no reason for his resignation.

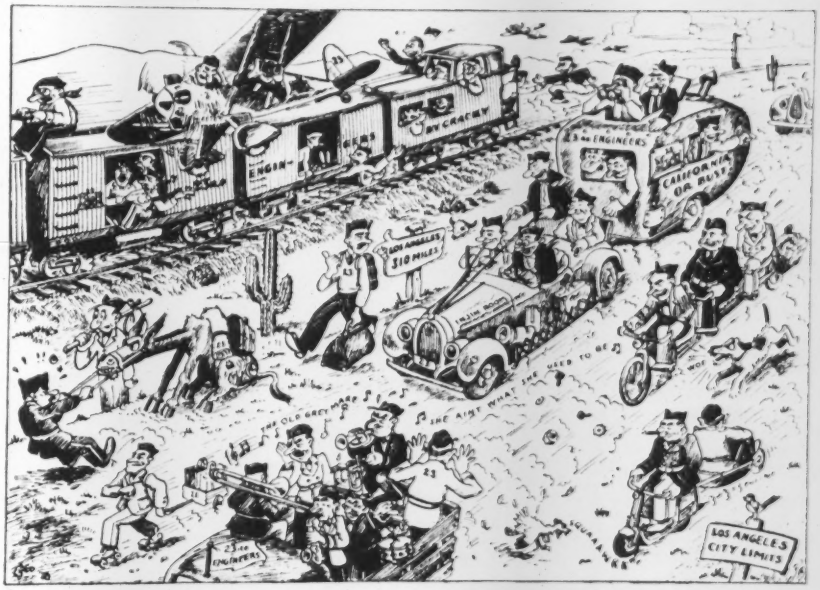
MAJ. ROY D. BURDICK, chief of the engineering and planning division of the U. S. engineers at Memphis, has been transferred to the Department of Military Science and Tactics at the University of West Virginia.

ADOLPH J. KOENIG, city manager of Fort Atkinson, Wis., has been appointed village manager of Wilmette, Ill. Before taking his post at Fort Atkinson, Koenig was city manager of Plymouth, Mich., and assistant city manager of Pontiac.

ROBERT SHEA, senior engineer in the bridge and ferry division of the Boston Public Works Department, has been appointed chief engineer of the city sewer division. Shea entered the city service in 1911 and became senior engineer in 1921.

CHARLES DE ST. MAURICE, for several years city engineer of Polusa, Calif. has resigned that position.

P. B. BRENEMAN has retired from his position as head of the department of mechanics and materials of construction at Pennsylvania State College. Breneman graduated from Pennsylvania in 1894, and immediately became an instructor in civil engineering there. Six years later he left his teaching post and was active in mine construction and operation until 1906 when he became an assistant professor of civil engineering at Purdue University. After two years there he returned to Pennsylvania to take the post which he held until his present retirement.



NINE WAYS TO GET TO LOS ANGELES

RUDOLPH K. BERNHARD, consulting engineer for Baldwin-Southwark Corp., at Philadelphia, has been appointed head of the Department of Mechanics and Materials of Construction at Pennsylvania State College. Bernhard was educated in England and Germany and was for ten years structural engineer for the German State Railway, and later practiced in Berlin with Karl Bernhard, Sr. In this country, he has been design engineer with H. G. Balcom, and with J. A. L. Waddell, of New York City. He once was research engineer with the Baltimore & Ohio on special investigation of bridges.

MARIANO MOCTEZUMA, who has held several high engineering positions with the federal government of Mexico, has been made dean of the engineering faculty of the National University of Mexico.

ARTHUR PEABODY, for nearly 40 years state architect of Wisconsin, has retired from that post.

ROGER C. KIRCHOFF, a member of the Milwaukee architectural firm of Kirchoff & Rose, has been appointed to the position of state architect of the Wisconsin engineering department. Kirchoff, a graduate of the University of Illinois, was formerly chief architectural supervisor for the Federal Housing Administration.

Prof. Inge Lyse to Leave For Norway Position

Inge Lyse, professor of engineering materials and in charge of the work at the Fritz Engineering Laboratory at Lehigh University, has resigned to accept the position of professor of reinforced concrete and solid bridges in Norway's Institute of Technology, Trondheim, Norway. Professor Lyse will sail from New York on Aug. 17 in order to be in Norway in time to begin the school year on Sept. 1.

A graduate of the Norway Institute of Technology in 1923, Professor Lyse came to the United States immediately thereafter and, during the following 15 years, has made an enviable reputation and a host of friends in the civil engineering field. His first work on hydro-electric projects in California was followed by a period during which he was principal assistant to the late W. A. Slater on the Stevenson Creek experimental arch dam. In 1927 he became assistant to F. R. McMillan, director of research, Portland Cement Association, and at the beginning of the American Concrete Institute column investigation in 1929, represented the P.C.A. in direct charge of experiments at Lehigh University under Professor Slater's direction. In 1931 he joined the faculty of Lehigh University as research assistant professor of engineering materials, became associate professor in 1933, and full professor in 1937. Since Professor Slater's death in 1931 he has been in charge of all work at the Fritz Engineering Laboratory and conducted graduate instruction in the department of civil engineering.

ENGINEERING NEWS-RECORD

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Editor, F. E. SCHMITT • *Editorial Staff*, V. T. BOUGHTON
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Editorial Offices at 330 West 42nd Street, New York

AUGUST 18, 1938

SINCE the collapse of the welded Vierendeel truss bridge in Belgium in March, many foreign journals have carried accounts of the failure. All engineers who have thus commented seem to agree that the welding, although poorly done, was not the primary cause. Likewise, all of them see in the extreme brittleness of the steel sufficient reason for the failure. In our comment at the time of the collapse, the procelain-like breaks of the steel and the butt-welded joints in the bottom chord were suggested as suspicious points. It is gratifying that those engineers who have written about the bridge believe that the initial bottom chord break, like the top chord breaks, did not occur at a welded splice. Much will be learned from the report of the Belgian commission that is studying the collapse, and American engineers will await its publication with interest. As Otto Bondy, European structural engineer writes in this issue, a combination of causes will probably be found to have been at the root of the failure, with major emphasis on the character of the steel. In the meantime, we can assume that welding as such was in no wise discredited by the collapse.

Mass Attack

SELDOM IS THERE opportunity to describe a more broad and vigorous attack on pollution than that which has been made in the Great Lakes region. When four cities like Niagara Falls, Detroit, Buffalo and Cleveland almost simultaneously are bringing their treatment works to completion the occasion is one of special significance. Chicago and Milwaukee, of course, have already made their contribution toward pollution abatement in the Lakes, as have several of the smaller cities. The works that are now being completed (see p. 197) will end pollution from four remaining major sources. Since the Great Lakes must serve in the dual role of water supply reservoir and catchbasin for the wastes of the millions of people who live along their shores, it is essential that the wastes be treated before discharge. Because this treatment has been neglected in many places water purification plants have frequently been taxed to the limit in furnishing a safe and decent product. Therefore, to record that new sewage disposal facilities of over 800,000,000 gallons daily capacity are being completed in this mass attack on Great Lakes pollution marks a major step forward in sanitation progress.

Snow Survey Results

IMPROVEMENTS in equipment and technique used in making snow surveys have reached a point where runoff predictions are dependable and accurate to a remarkable degree. The almost exact prediction three months in advance of the runoff yielded by an important drainage basin, represents an achievement of great value to power companies, irrigated lands and areas subjected to flood menace. Under the direction of Dr. J. E. Church, University of Nevada, the interchange of ideas and information on snow surveys has been extended to world-wide scope, and an International Commission of Snow is functioning effectively. This undertaking promises to increase the value and precision of snow surveys still further and make them a regular part of hydrological studies on all important water sheds that have snow sources.

Plant Development

PERFECT MIXING is the essential requirement of soil stabilization. It is most vital if the soil is processed with an artificial binder—a bitumen, hydraulic cement or even a simple moisture-retaining chemical salt. As mixing is commonly performed in roadbuilding it is a cumbersome process of many repeated operations, and control demands good judgment and exacting inspection. Because the personal element is so large a factor in the success of road mixing the roadbuilder is looking ahead to plant development that will assure calibrated results. An example is the salt-processed earth road work in Michigan described on a following page. This example is not a lone one, for trials of plant-processed soils in many states are gradually building up a reliable practice. Thus plant development is being recognized as vital. To attain the essential objective of precise proportioning and intimate mixing of binder with earth aggregate, machine methods offer the best promise.

Tomorrow's Practice

ENGINEERING progresses in large measure as the result of practical experience. Boldness backed by skill in the use of construction equipment frequently produces a novelty today that becomes accepted practice tomorrow. This is particularly true of bridge pier construction in deep water, one of the most difficult tasks that face the engineering constructor. The Deer Isle bridge pier

work in Maine is a present example. Assembling a coffer dam on land, cutting its lower edge to fit the irregular rock surface of the deep ocean floor on which it is to sit, and then picking it up bodily and setting it in place was made possible only because of the availability of floating equipment capable of lifting such great loads. Yet what was but an idea of yesterday is a proven possibility today. Thus the bridge engineer has opened to him a new way in which to build piers economically in places that would have been considered out of the question a few years ago.

New Fatigue Questions

WHAT HAPPENS in fatigue failure has been a mystery since the first discovery of the limited endurance of metals under repeated stress, more than half a century ago. It seemed clear that endurance failure implied some deterioration of the material during the alternating or repetitive stressing, probably in the form of continuous growth of minute cracks. Now, however, the crack hypothesis and indeed the entire theory of progressive deterioration is placed in doubt by the results of new fatigue tests made at the University of Wisconsin, and the mystery of fatigue and endurance becomes deeper than before.

Prof. J. B. Kommers found in extended tests that repeated overloading ordinarily damages the material, but at the same time has an opposite effect, tending to increase the strength, and that in some cases the strengthening effect is large enough to overbalance the damaging effect. The normal effect of overload stressing was reduction of the endurance limit, by an amount that increased with the degree of overstress and with its duration. In individual instances, however, overstress up to 30 per cent produced no damage, and in other instances the endurance limit was actually raised above that of the original material.

Further, some tests showed that a sample damaged by overstress could be restored to its original endurance strength by understress. Long-continued understressing of progressively increasing amount made it possible to raise the endurance limit of some specimens by 20 to 25 per cent. Some unexplained change of structure of the metal seemed to be going on during the continued action of repetitive stressing.

The practical importance of these observations is due to the fact that the material of nearly all machines and structures is subject to constantly varying or oscillating stress, rather than to fixed static stress. Fatigue is active in bridges and building frames as well as in machines, according to W. M. Wilson's recent findings. Their actual strength therefore depends on their endurance limit. But as this limit is always much lower than the static strength, and generally is lower than the yield point, safe design must consider fatigue phenomena as fully as the customary testing-machine figures.

For these reasons it is to be hoped that the confusing facts of damage, repair and improvement of material by repeated stressing will be more fully explored. Whether the crack theory is finally confirmed or not, we need to have exact knowledge of just when and how a piece of steel—or other material—is weakened or is strengthened by repetition of loading. Until we acquire this knowledge we will not have reached the point of assured safety in design.

Floods on Minor Streams

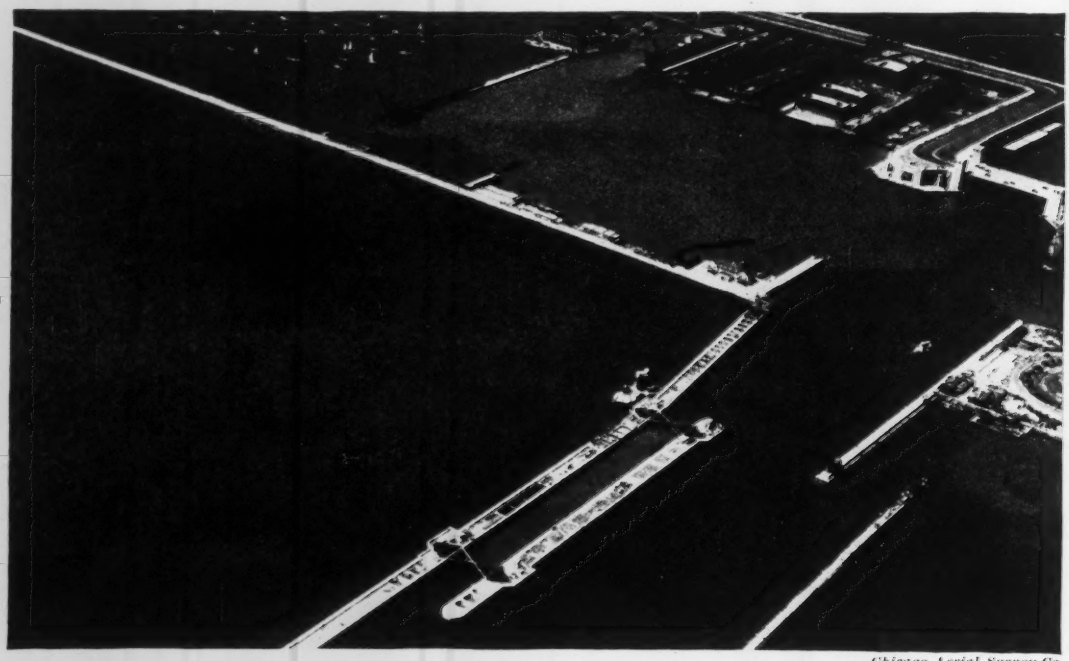
JULY'S UNUSUAL RAINS caused many traffic interruptions and a substantial total of damage by floods in creeks, brooks and minor rivers. Measured by the damage, flood-protection studies would pay on most of these streams, and probably not a few would prove to justify the construction of flood-protective works to eliminate recurring physical damage and attendant losses.

An important point is that in nearly every case the situation is strictly local in character, affecting a township or two, rarely several counties. By the same token the responsibility for dealing with the floods is local. Yet under the policy laid down by Congress in the 1936 and 1938 flood-control acts the federal government is vested with the responsibility for the control of all floods. Necessarily federal action will take a long time, since the number of minor streams on which floods may occur is very large. A better way to deal with local floods than depending on the cumbersome machinery of federal action is clearly desirable.

The federal-aid plan recently suggested in this column (*ENR* July 28, 1938, p. 103, "No More Self-Protection?") is specially adapted to the case of local floods, and promises to prove far more effective than the procedure set up by the federal acts. It would place initiative and responsibility for both planning and construction on the local people, where it belongs, while the federal government by auditing the plans would see that proper standards were maintained. It would go far toward assuring prompt and effective action.

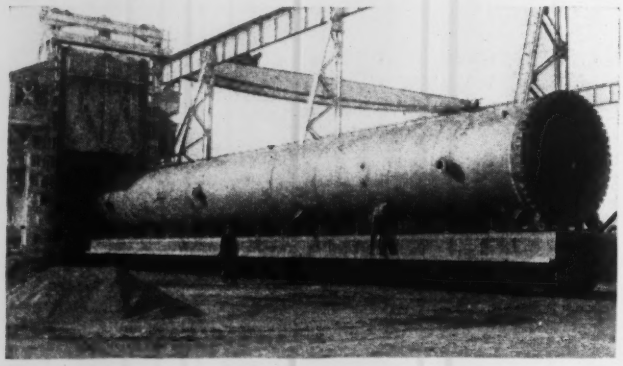
Costs would be assessed on the interests benefited, and the federal contribution would at once provide an incentive and give recognition to the national benefit obtained through general control of floods. The federal-aid system, in brief, would make flood protection workable, efficient, rapid and equitable, and would be clear of many legal questions in which the present federal plan is involved.

PICTURES IN THE NEWS



Chicago Aerial Survey Co.

CONTROLLING WORKS at the mouth of the Chicago River will be in service by the end of the year when the diversion from Lake Michigan must be reduced to 1,500 sec.-ft. Contract payments of 78.5 per cent of the total cost of $2,500,000 were made recently. Triangular sector gates mounted on 32,000-ton concrete gate blocks control the quick flow of water in and out of the 80x600-ft. lock. The gates operate against an 8-ft. head in either direction.



INTO THE "HOT BOX" to be stress-relieved at the Birmingham plant of the Chicago Bridge & Iron Co., this 80-ft. creosoting cylinder, 8 ft. 4 in. in diameter and made of 1¼-in. thick plates, was fabricated for the International Creosoting & Construction Co., Texarkana, Texas, where piles and bridge timbers will be impregnated in it at 200-lb. pressure.

Photo by F. F. Leggat

MODERN MACHINERY does its part in reconstruction of a historic building. This small crawler crane is working in the moat of Fort Henry, overlooking Kingston, Ont. The fort was built following the War of 1812, and was never used.

Cleaning-Up The Great Lakes

E. J. CLEARY
Assistant Editor, *Engineering News-Record*

New sewage disposal plants at Niagara Falls, Buffalo, Cleveland and Detroit will free the Great Lakes of a daily pollution load of more than 800,000,000 gallons

EMPHASIS on pollution abatement in the heavily industrialized areas of the Great Lakes region has resulted in the construction of many sewage treatment works. Aside from the activity at Chicago and Milwaukee, where sewage disposal facilities have been vigorously advanced for many years, the new plants nearing completion at Niagara Falls, Buffalo, Cleveland and Detroit are notable because of their size and design features. And in freeing the lake waters of more than 800,000,000 gal. of sewage daily, the plants at these four cities will make an important contribution toward maintaining the purity of water supplies served in scores of communities.

Outstanding among the impressions gained from a visit to these new works is a vivid picture of increasing complexity in treatment practice. This is not the result of drastic changes in orthodox principles of treatment but reflects instead the refinements of method, largely mechanical, which are being applied to even the simplest process. Represented in these plants are many recent research and laboratory developments which have been directed toward the improvement of purification methods as well as to perfection of plant operation and control. A few of these developments are: screening shredders and grinders, improved sludge dewatering and incinerator equipment, ingenious automatic control systems, magnetite strainers, fine screens with coal mat filters and novel aeration devices.

Among other things, eye and nose appeal have been accorded solicitous attention. Plant structures, for instance, while not ornate, have received thoughtful and pleasing architectural treatment. Settling tanks, in many cases, are covered, and otherwise unsightly operations have been made inconspicuous or eliminated through the use of mechanical devices. Even more significant is the care bestowed on the installation of odor elimination facilities. Exhaust fans, ventilating shafts and turbine roof ventilators, are now found as essential appurtenances in design. And in cases where incinerators are used, the chimney construction is generally such that an annular space is provided between the inner and outer walls of the stack through which foul odors can be exhausted.

At Niagara Falls is perhaps the most unusual disposal plant in the world. It can lay claim to this distinction on two counts—its construction on the side of the Niagara River gorge, and the method of treatment to be employed. Departing from the usual type of partial sewage treat-

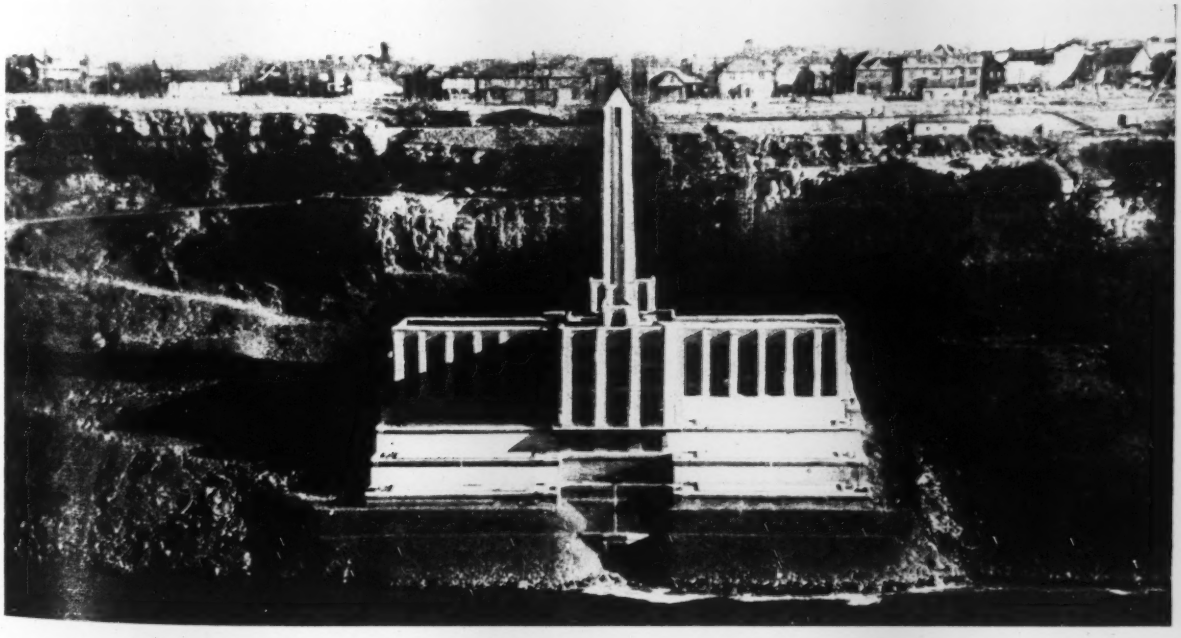
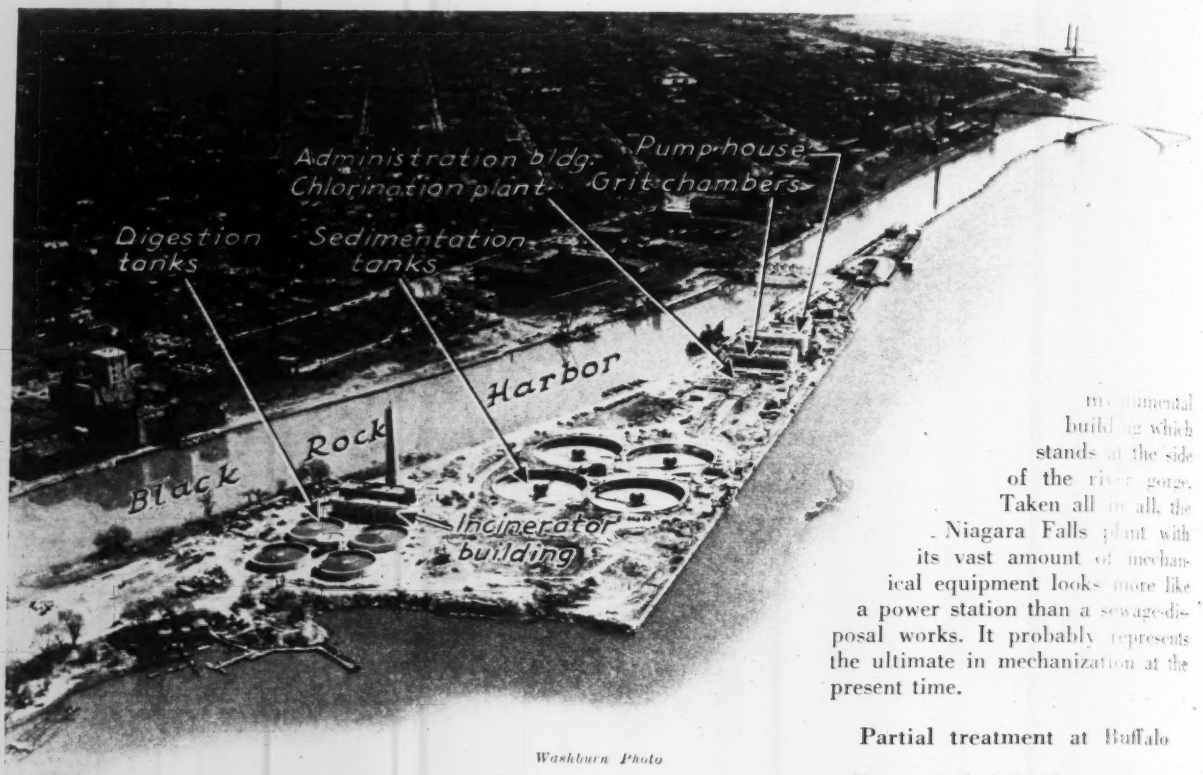


Fig. 1. The Niagara Falls partial treatment plant is located on the side of the rock gorge.



Washburn Photo

Fig. 2. **Buffalo's treatment plant occupies Bird Island in the Niagara River.** The monumental building which stands at the side of the river gorge. Taken all in all, the Niagara Falls plant with its vast amount of mechanical equipment looks more like a power station than a sewage-disposal works. It probably represents the ultimate in mechanization at the present time.

ment installation, the designers, Watson & Streander of New York, have installed fine screens adapted to function as filters using an anthracite coal mat. Screenings will be dewatered in centrifugal machines prior to incineration.

Located at the base of the gorge on ground having a slope of about 40 deg. from the horizontal, the plant is supplied by an intercepting tunnel running through rock 120 ft. below the top of the escarpment. Dropping down through a 60x36 in. vertically-mounted venturi meter, the sewage enters the central gallery of the building in which all the treatment devices are housed. These include: 1 in. bar screens, mechanically-cleaned grit chambers, six 22-ft. dia. fine screens, chlorine contact tanks, two constant-feed type centrifuges and two 80-ton multiple hearth circular furnaces with separate drying zones. The latter is designed to provide low-temperature drying (and thus prevent surface charring) followed by high-temperature burning. Foul gases from the drying zone are finally passed through the high-temperature zone to eliminate odors.

When treating dry weather flows up to 60 m.g.d., a 2 to 3 in. mat of $\frac{1}{16}$ in. coal will be superimposed on the screens so that they serve as coarse filters. The engineers believe that 25 per cent or more of the solids can be removed in this manner; the screens without the coal mat will remove 8 to 10 per cent of solids. During stormweather flows in volumes up to 90 m.g.d., the brushes which sweep off the accumulated solids will be lowered and the coal mat removed to permit the screens to function as fine screens with $\frac{1}{32}$ in. slots.

To supply the water for making the chlorine solution used to disinfect the plant effluent, a small water-filtration plant has been installed to treat the clarified sewage. For this purpose pressure water filters, with a capacity of 300,000 g.p.d. are used.

Other auxiliaries used for plant operation include direct-connected motor compressors for supplying air to the pneumatic ejector system with which the screenings and grit are handled and an elaborate layout of spiral screw-type conveyors for distributing coal to storage and to the screens. Ventilation has received special consideration since all the treatment devices are housed in the

Partial treatment at Buffalo

Disposal of sludge by incineration and the installation of ventilation facilities for odor control at the Buffalo treatment works reflect present-day thinking in sewage disposal practice. This new 150 m.g.d. plant, providing partial treatment by means of sedimentation and chlorination, is nearing completion and will be placed in operation this summer. Greeley & Hansen, of Chicago, are the consulting engineers.

The incinerator is of the "flash-drying" type similar to that installed at the Calumet plant in Chicago (*ENR*, Jan. 23, 1936, p. 116). Four units, each of 100-ton capacity, will be used in Buffalo. Previous to incineration, the sludge will be partly digested and then filtered.

The incineration process provides four cycles of operation, namely, drying, burning, odor elimination and dust collection (Fig. 4). Sludge cake from the filters is first mixed in a pug mill with a portion of previously dried material to produce a homogeneous mixture and it is then dropped into the dryer. Here it is brought into contact with hot gases from the furnace and drying takes place. Dried sludge, separated from the moisture-laden gases in a cyclone separator, is then conveyed either to the furnace or removed from the system for use as fertilizer.

The furnaces are of the flash type, equipped to use powdered coal as auxiliary fuel. They are also designed to receive the moisture-laden gases from the separator and raise their temperatures high enough for odor removal. Stack gases from the furnace are passed through a second cyclone separator for fly ash removal.

The schematic diagram (Fig. 4) illustrates the various steps in drying and incineration.

Ventilation for odor control

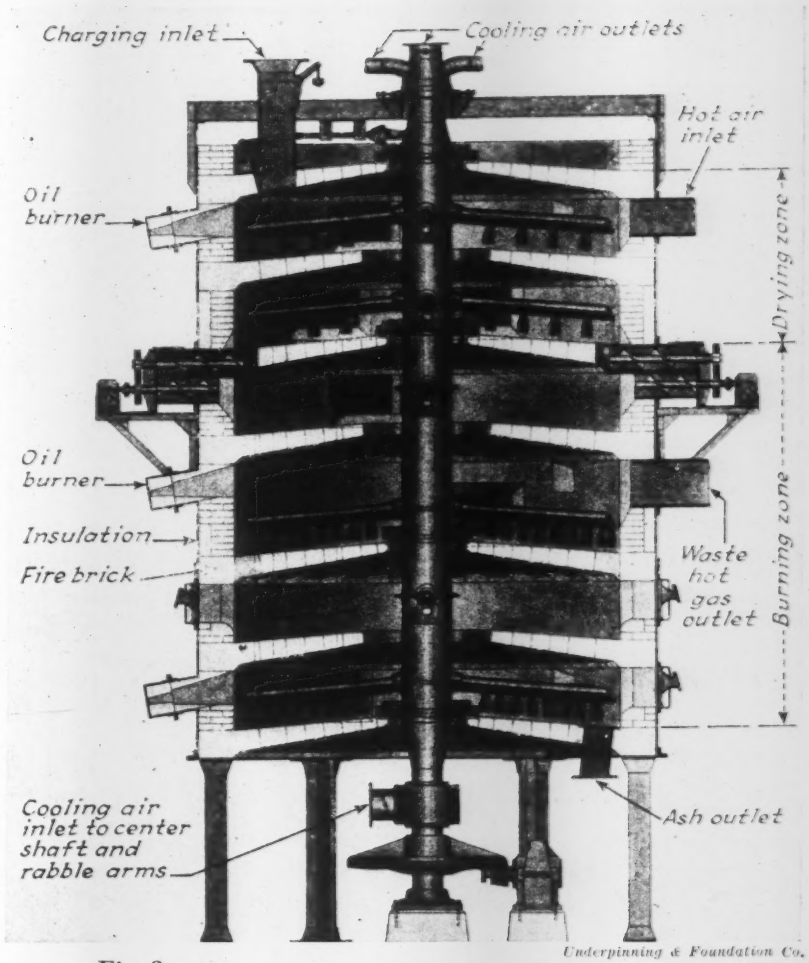
Like Niagara Falls and Cleveland, Buffalo has made provision for ventilation of plant structures to prevent odor dissemination. This was considered highly important because Bird Island, on which the plant is located, stands directly in the path of the prevailing winds that pass over the residential area of the city. Consequently, in order to prevent any possibility of nuisance all places where odors might arise have been closed and vented into a tunnel which exhausts in the double-wall stack erected at the incinerator building.

Among the places that have been made air-tight are the wet well, grit and screen chambers, and the conduit channel leading to the battery of open sedimentation tanks. The sewage entering the latter will be prechlorinated for odor control in the tanks. At Cleveland similar precautions have been taken.

Detroit plant moving ahead

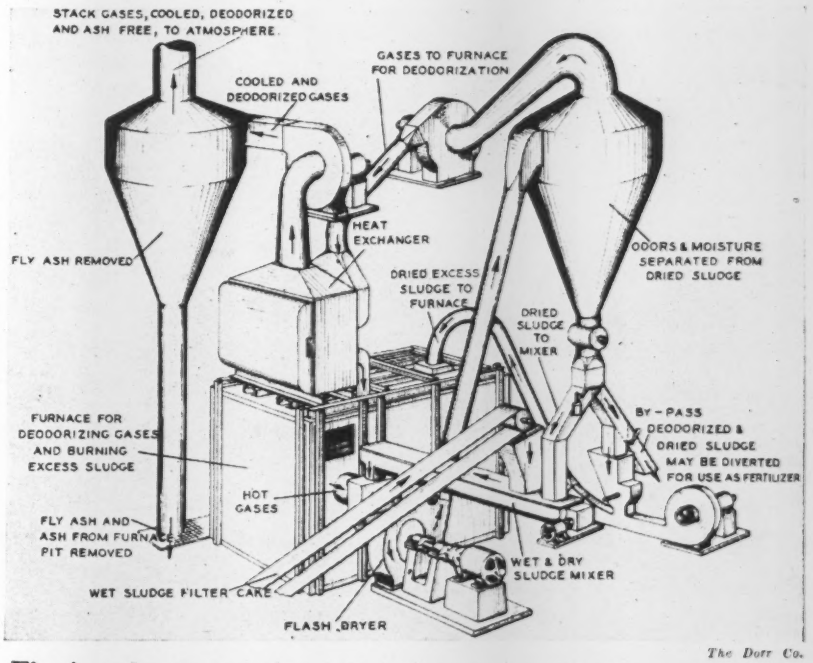
In Detroit construction work has passed the halfway mark on one of the largest disposal projects in the world—ten miles of intercepting sewers and a sedimentation and chlorination plant designed to handle 420 m.g.d. Sludge will be dewatered and incinerated, and in addition facilities will be installed to provide digestion and elutriation for about one-eighth the volume of sludge produced. Results from the latter will determine whether this additional processing should be adopted for the entire sludge output. The sludge incinerator installation—rated at 1,200 tons of filter cake per 24 hours—is of unusual capacity. It consists of four circular vertical furnaces, each containing 12 superimposed rabbled hearths.

All sewage reaching the plant must be lifted about 23 ft. and for this



Underpinning & Foundation Co.

Fig. 3. Sludge incinerator of the type used at Niagara Falls.


STACK GASES, COOLED, DEODORIZED AND ASH FREE, TO ATMOSPHERE
GASES TO FURNACE FOR DEODORIZATION
COOLED AND DEODORIZED GASES
HEAT EXCHANGER
FLY ASH REMOVED
ODORS & MOISTURE SEPARATED FROM DRIED SLUDGE
DRIED EXCESS SLUDGE TO FURNACE
DRIED SLUDGE TO MIXER
FURNACE FOR DEODORIZING GASES AND BURNING EXCESS SLUDGE
BY-PASS DEODORIZED & DRIED SLUDGE MAY BE DIVERTED FOR USE AS FERTILIZER
HOT GASES
FLY ASH AND ASH FROM FURNACE PIT REMOVED
WET & DRY SLUDGE MIXER
WET SLUDGE FILTER CAKE
FLASH DRYER

The Dorr Co.

Fig. 4. At Buffalo the sludge incineration process provides four cycles of treatment, namely, drying, burning, odor elimination and dust collection.

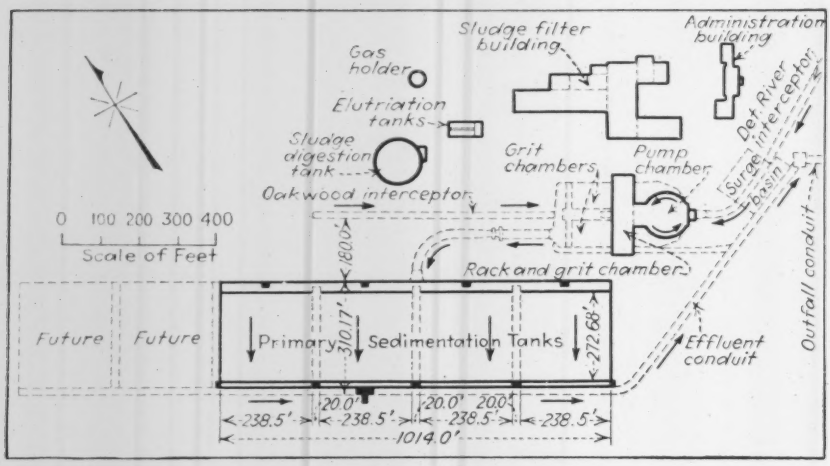


Fig. 5. General layout of the 420-m.g.d. Detroit partial treatment plant.

purpose six centrifugal pumps will be employed. Because of their large size (two of the largest are 180 m.g.d. capacity) and the big opening through the pumps, no racks or screens will be used ahead of them. Design of the treatment units depart from standard practice in several instances. For example, economic studies of the grit chamber indicated that it would be cheaper to build tanks with a long (150 ft.) and deep channel rather than use smaller but wider tanks because of the costly curved inlets required in the latter.

The rectangular settling tanks, too, are long and relatively narrow. Each tank with a length of 270 ft. is divided by partitions so that there are seven channels, each 16 ft. wide. This was done to provide better flow distribution and increase sedimentation efficiency.

Design of the effluent diffuser outlet in the Detroit river offered special problems as revealed by model studies. The original plan called for an elbow at the end of the outfall in the bed of the river discharging the plant effluent upward at a velocity of 8 ft. per second. Model tests showed, however, that this would raise the level of the river some 13 in. in the vicinity of the discharge and thus create a decided menace to navigation. Accordingly, the outlet had to be redesigned so that the flow would be diffused horizontally.

Cleveland's vast program

The culmination of work covering more than a quarter century is represented at Cleveland, where George B. Gascoigne and his associates are putting into operation the 123 m.g.d. Easterly plant and completing construction and enlargement of the 45 m.g.d. Southerly works. At the latter place, elaborate sludge-handling facilities have been provided to serve both the adjacent treatment units and the Easterly plant, some 13.5 miles away.

The Easterly activated-sludge plant, design details of which were described in this journal (*ENR* Jan. 9, 1936, p. 52) is now in the "tuning-up" stage. Because of the plant's location on the lake edge in a high-class residential area, extra precautions have been taken to minimize any possibility of nuisance. It was partly for this reason that all sludge disposal facilities were located many miles distant at the Southerly plant, far removed from the urban scene.

The following precautionary measures against nuisance were carried out in the final plant design: All screenings are passed through comminutors and the shredded material is returned to the flow; grit chambers and detritors are housed so that there is no exposure of sewage during this process; grease flotation and pre-settling tanks are completely covered and equipped with a forced ventilation system which discharges vapors through a high stack; and facilities are provided for deodorization by pre- and intermediate chlorination, the latter applied prior to grease flotation.

The Southerly treatment plant, originally an Imhoff tank-sprinkling filter installation with covered sludge drying beds, has undergone a substantial transformation since its construction in 1926. In addition to two-stage sludge digestion facil[illegible] and the installation of dewaterin[illegible] and incineration devices now be[illegible] completed, the sewage treatme[illegible] processes have been modernize[illegible] in an interesting manner.

In order to increase the [illegible]kling filter capacity an abbreviat[illegible] activated-sludge treatment will [illegible] used prior to filtration, consisti[illegible] of a short period of aeration foll[illegible]ed by sedimentation of the mixed liquor. The aeration tanks are of the spiral-flow type one unit of which is provided with porous plates and the second with swing-tube diffusers. The latter is a new development and consists of a series of carbon tubes attached to an air manifold in such manner that individual units can readily be lifted from the tank for inspection and cleaning without interrupting operations.

Tapered aeration used

Another interesting feature of the aeration system is the provision enabling graduation in the application of air to obtain the advantages of so-called "tapered aeration" (namely, supplying oxygen in proportion to the oxygen demand curve, whose characteristics call for maximum aeration at the initial period of treatment followed by greatly diminished supply). To accomplish this purpose, plates or tubes for supplying air are installed in greater number at the entrance of the tank and reduced in number as the flow progresses through the tank.

Aerated and settled sewage is next treated on six trickling filters, each one acre in size, composed of 2-in. broken limestone 10 ft. deep; distribution is effected through fixed nozzles spaced on 10-ft. centers. The secondary settling tanks, originally consisting of three adjoining 75-ft. square tanks, have been converted into three rectangular tanks each 16 ft. wide and 229 ft. long and provided with downward flow magnetite strainers.

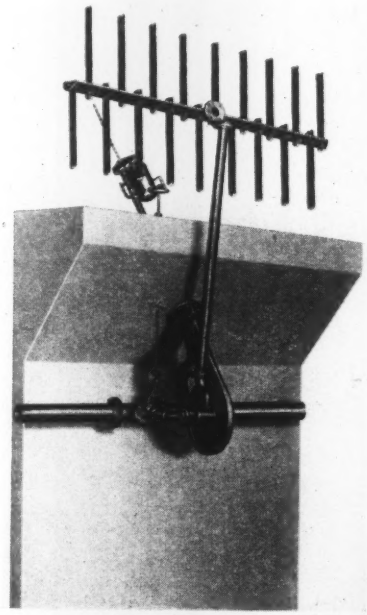
Sludge disposal facilities

Provisions for sludge disposal are quite complete. The 12 digestion tanks (with a total capacity of 2,205,000 cu. ft.) are arranged in two clusters of six tanks each, each cluster grouped around a central chamber housing the hot water heat-

ers and control mechanism (*ENR*, Jan. 9, 1936, p. 52). The tanks are provided with floating covers for gas collection; gas storage is provided in a 60,000 cu. ft. spherical tank.

Sludge pumped from the Easterly plant will be retained for a short period prior to digestion in four cone-shaped tanks (Dortmund type) 26 ft. in diameter and 28 ft. deep. They are designed to concentrate sludge, which collects in the small end of the cone where it is drawn off. Supernatant liquor displaced by incoming sludge, passes over a peripheral weir and is discharged into the treatment plant influent.

After digestion the sludge is



Chicago Pump Co.

Fig. 7. Detail of the swing diffuser equipment with carbon tubes.

piped to a disposal building housing eight 300-sq.ft. string-discharge type vacuum filters and four 100-ton circular furnaces with superimposed rabbled hearths. Ferric chloride alone or in combination with lime will be used for conditioning the sludge. Chemicals will be purchased in railroad car lots and provisions have been made for bringing the cars directly into the building for unloading. The chemical dosing arrangements are automatically controlled.

Dewatered sludge cake may be disposed of by storage for fertilizer use, or it can be delivered to the furnace by belt conveyors equipped with weighing devices. The final ash residue is removed by means of a pneumatic system.

Sludge gas will be used principally for operating two 390-hp. internal combustion engines directly connected to blowers supplying air for the abbreviated activated-sludge process. An interesting feature of this installation is the scheme of cooling the engine water, which can be circulated through a grid of pipe submerged in the aeration tanks where it is exposed to the flowing sewage. This will be employed only when the waste heat from the engines is not needed for heating the digestion tanks.

Cleveland also operates a third treatment plant located in the industrial area along the lake shore. This is an Imhoff tank installation of 36 m.g.d. capacity built in 1922 and it, too, has been improved. In fact, this plant has served as the testing laboratory for much of the equipment and devices that were later included in the Easterly and Southerly jobs.

In addition to the primary treatment afforded by Imhoff tanks, the plant now incorporates separate sludge digestion, vacuum filtration and sludge incineration, all installed since 1933. Because the plant handles wastes from meat packing houses (equivalent to the wastes from 100,000 persons) a grease flotation process has also been added. Aeration with the introduction of dry chlorine gas is used for separating the grease.

An inspection of these new plants demonstrates in striking fashion the strides forward that have been made in the technical phases of sewage disposal. In this respect, they demonstrate the happy results of long and patient cooperation among sanitary engineers, research workers and equipment manufacturers. It is also of great interest to note how the problem of sludge disposal has been met. In every case incineration has been employed for final disposal, either with or without prior digestion. Thus it appears evident that where large quantities of solids must be handled, incineration is now considered the most economical and satisfactory method available.

What it all means

These new plants do more than typify progress in treatment practice, however. In a sense they are the concrete expression of enlightened public opinion in the matter of pollution abatement. It is no mere coincidence that four major additions to sewage-treatment facilities in this area should reach completion almost simultaneously. The motivating force behind these projects as well as in the initiation of scores of smaller plants in the Great Lakes area, has been the recognition that public health is more than a matter of wishful thinking.

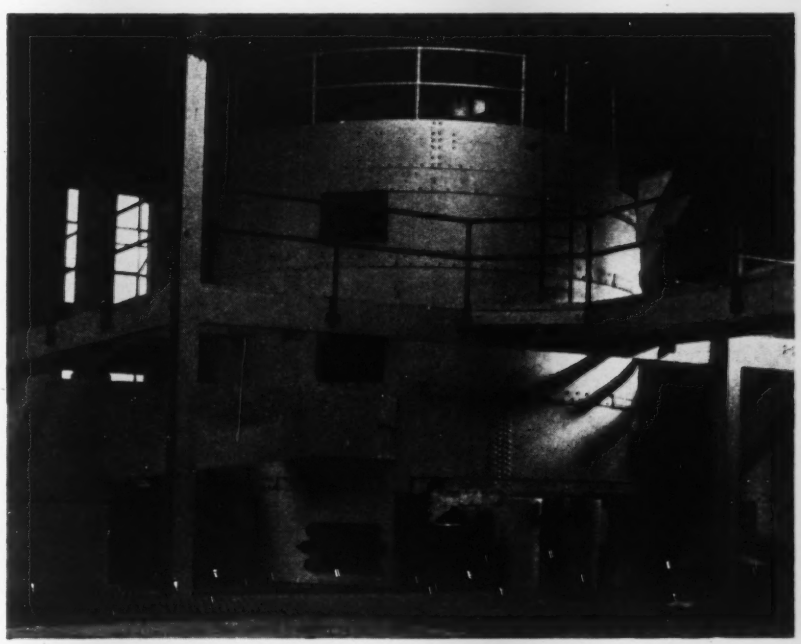


Fig. 8. Vertical circular rabbled hearth incinerator at Cleveland. Four of these units, each with a capacity of 100 tons, are used at the Southerly plant.

Stabilization Goes Mechanical

A Michigan road job combines machine spreading and traffic compaction with central plant prestabilization of the gravel

IN LAYING a stabilized gravel road surface in Jackson County, Michigan, the contractor found that his central plant could put out 1,000 to 1,200 cu.yd. of prestabilized material while his spreading procedure held him down to one-half that amount. Furthermore he found that it required a dozen men to lay the required side forms and to service the ordinary spreading equipment. This cost too much. The accompanying illustrations and the description that follows tells how the double requirement of more spreading speed and reasonable costs was satisfied.

To increase the speed of spreading, to eliminate forms, and to control the amount spread, a bituminous tamping finisher was obtained. By operating it at high speed its capacity was raised to about that of the central mixing and proportioning plant. This eliminated the bottleneck. The finisher was not changed for its new application except to raise the tamper to permit spreading twice the thickness of layer ordinarily spread. In consequence, the tamper cannot effect as much compacting as it would on bituminous mixes, but the machine was bought primarily as a spreader, compaction being left to traffic, to the trucks bringing in the material and to a road roller.

The job to be done

The Jackson County road is 6.1 mi. long and a part of a state job of 180 mi. of stabilized road let last year and now about 75 per cent completed. Lack of money precluded finishing the road with a bituminous top as originally contemplated, and it was decided to use two layers of stabilized clay-gravel on top of the base which has been graded and prepared in accordance with standard state highway practice.

The soil in the locality is a fairly uniform, very fine sand with little clay and a thin layer of top soil. It absorbs water rapidly. The topography being somewhat rough, cuts were made to balance fills which were placed in 10 to 12-in. layers wetted and rolled. Up to June, rain had been so frequent that little or no sprinkling was required. Thereafter the subgrade was sprinkled only to prevent absorption from the premixed material brought in.

The specifications call for a 21-ft. width of stabilized gravel laid in two layers 3½ and 4 in. thick to compact to 6 in. The finisher lays two 10½-ft. strips of the specified thickness. The edges are banked with loose material on the 8-ft. shoulders. The structure is similar to the ordinary gravel secondary road in Michigan. Crowns for stabilized gravel are ordinarily 4 to 5 in. and for bituminous top 2 in.; for this job a compromise of 3 in. was adopted since as soon as money is available a bituminous top will be provided, the road carrying a fairly heavy traffic (up to 5,000 vehicles per day), probably too heavy for the type of surface being placed.

From an average of several tests the stabilized material as it goes on the road consists of 17.2 per cent of clay, 7 to 8 per cent of water, 20 lb. per cu.yd. of rock salt and the balance gravel, 98 per cent of which has passed a ¾-in. screen, 79.3 per cent a ¼-in. mesh and 43.7 per cent a 10-mesh. Some 16,000 cu.yd. of stabilized material is required.

Premixing was adopted

Last winter the contractor opened a pit near the center of the section and prepared the gravel by crushing

Fig. 1. Compaction of stabilized mixture is accomplished a layer at a time by traffic and by rolling with a multi tired roller.

Fig. 2. Dry subgrade is sprinkled to prevent absorption of moisture from stabilized mixture after it is spread.

Fig. 3. Pit plant proportions and premixes gravel, clay and salt.

Fig. 4. A standard tamping finishing machine for bituminous surfacing with slight changes spreads premixed stabilized gravel.

all that would not pass a ¾-in. screen. He also wasted about 5 per cent of fines passing a ¼-in. mesh. Tests of the gravel which was stocked in three piles showed 99 per cent passing ¾-in., 78 per cent passing ½-in., 33 per cent passing 10-mesh and 2 per cent clay. The specifications called for 100 per cent through ¾-in.; 60 to 90 per cent through ½-in. and 35 to 50 per cent through ¾-in.; 60 to 90 per cent through ½-in. and 35 to 50 per cent through 10-mesh. The clay plasticity index is 20 to 23.

This spring a stabilizing plant was set up. Clay comes from a pit ½ mi. away. The plant consists of a gravel proportioner, a clay shredder and a salt feeder all delivering to a pugmill. The pugmill delivers directly to trucks, 5 to 12 being required depending on the haul.

A dragline handles the gravel and clay from stockpiles to the 2.7-yd. hopper of the gravel proportioner and the 2-yd hopper of the clay feeder. The latter has a wide base with chain-and-bar conveyor across the bottom and another chain-and-bar conveyor across the outlet to regulate the discharge to a belt conveyor carrying the clay to a shredder consisting of two dissimilar-sized rolls running at different speeds. The larger one is 24 in. in diameter and smooth. The smaller one, 12 in. in diameter, has six longitudinal bars extending ¾ in. above the surface and set just to touch the smooth roll. This treatment breaks the clay into small pieces. Before the clay reaches the rolls it passes under screws which eliminate large lumps or stones that would not pass the rolls.

Passing the rolls the clay drops on top of the stream of measured gravel on a 24-in. conveyor belt. A few feet farther along the salt is fed onto the belt by an automatic chain feeder. The material is elevated to the twin shaft pugmill 8 ft. long which has 14 paddles on each shaft driving the material forward and 4 paddles at the discharge end set in reverse thus adding to the mixing action. Water for a spray pipe over the pugmill is pumped from a small tank under the mill fed by a pump at a creek 150 ft. away. The discharge cutoff gate through which the trucks are loaded stores a small amount of material until another truck can get

into place. The pugmill operator loads the trucks and can start or stop the clay and gravel mixing setup by cords attached to a starting lever on the latter.

The capacity of the mixing plant is 120 cu.yd. per hour but on the average the plant operates at about 80 per cent efficiency. On the road the spreader which has a top speed of 19 ft. per min. can operate continuously if trucks are spaced properly to feed the 3-yd. spread hopper. End dump trucks back up to the hopper until the tires meet rollers on the front end of the hopper. The spreader shoves the truck (the clutch disengaged) forward as the load is dumped into the hopper. Compaction, as noted, is by traffic and by 8 to 10 passes of a multi-wheeled pneumatic tire roller drawn by a small rubber-tired tractor. Pending the arrival of a tractor a team was used.

Following several days of dry weather it became necessary to sprinkle the base prior to spreading the stabilized material since the fine sand absorbs moisture out of the mixture and the evaporation from the surface was past. Unless the days are dry, common salt holds the moisture sufficiently until compacting is secured. During extremely dry weather it has been found desirable to add water to the salt mixtures by sprinkling during the compaction period. This serves to replace the water drawn off by evaporation which is needed to dissolve the salt.

A close control of the amount of material placed is obtained. Up to the middle of June, F. G. Cheney, the contractor, stated that he had used 9,200 cu.yd. and his calculated return was within a few yards of the same amount. This accuracy is accomplished (1) through close finishing of the subgrade and (2) through the self-leveling device of the finisher which holds the layer spread to a constant thickness. The tamper has a ⅜-in. face, a throw of ¼ in., and a vibration rate of 1,200 strokes per minute. It is designed to compact layers of bituminous materials of a maximum thickness of 2½ in. instead of the 3½ to 4½ in. of stabilized gravel.

The highway is being constructed by the Michigan State Highway Department for which Murray D. Van Wagoner is commissioner and H. C. Coons, deputy commissioner in charge of construction and operation.

Brittle Steel a Feature of Belgian Bridge Failure

O. Bondy

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Wreckage suggests that design, erection, welding and steel probably all contributed to the collapse

Pending the report of the Belgian commission appointed to investigate the collapse, on March 14, of the 245-ft. span welded Vierendeel truss bridge over the Albert Canal near Hasselt, Belgium, the cause of the failure cannot be stated definitely. Nevertheless, a personal inspection of the wreckage reveals a number of facts about the failure, and the following notes may be helpful to structural and welding engineers in forming their own conclusions.

It will be recalled (*ENR*, May 5, 1938, p. 564) that eyewitnesses reported that one of the cross girders began to fall off first, followed by the opening of a large crack in the lower chord of the bridge, which made it necessary for the upper chord to act as an arch. Then, under the resulting horizontal thrust, one abutment sheared off, followed by breaks in the upper chord and the collapse of the span in three parts. About six minutes elapsed between the loud report of the first crack and the final collapse of the bridge. The bridge weighed 646 tons, was 14 months old and cost about $125,000.

In the Vierendeel type of truss there are no diagonal members, and chords as well as verticals are subjected to bending moment in addition to axial stress and shear. Early trusses of this type were riveted, but during the past five years some 50 welded Vierendeel bridges have been erected in Belgium. Extensive laboratory tests have accompanied this work, and methods of calculation have been developed to a high degree, one of the latest publications on the subject being by Professor Louis Baes in *L'Ossature Metallique*, (Brussels) December, 1937.

Quality of the steel

The accompanying photographs of some of the important details of the Hasselt Bridge will be found informing. The steel used is understood to have been Belgian St. 42, having a tensile strength of 42 to 50 kg. per sq.mm., equal to about 26.6 to 31.6 tons per sq.in. This Belgian steel is of Thomas quality, and was used both for the plates and wide-flanged beams. The maximum thickness of plate used was about 2⅛ in., in the top chord. Although such thicknesses are not unusual in modern welded construction, they may have formed a source of danger, particularly in view of the small (about ⅜-in.) fillet welds which joined the webs to the flanges. Also, the homogeneity of thick plates has always been a matter of concern to rolling mills and consumers. On the other hand, welded plate girders have been built in Germany with flange plates up to 3½ in. thick, although these were of specially rolled sections, mainly of the triangular bulge type.

It may be supposed that the carbon content of the steel was not more than

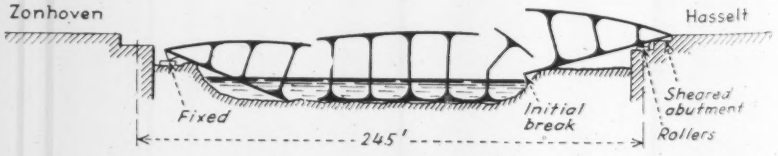

Fig. 1. After the collapse the Hasselt Bridge looked like this. In addition to the major breaks there were many secondary fractures.

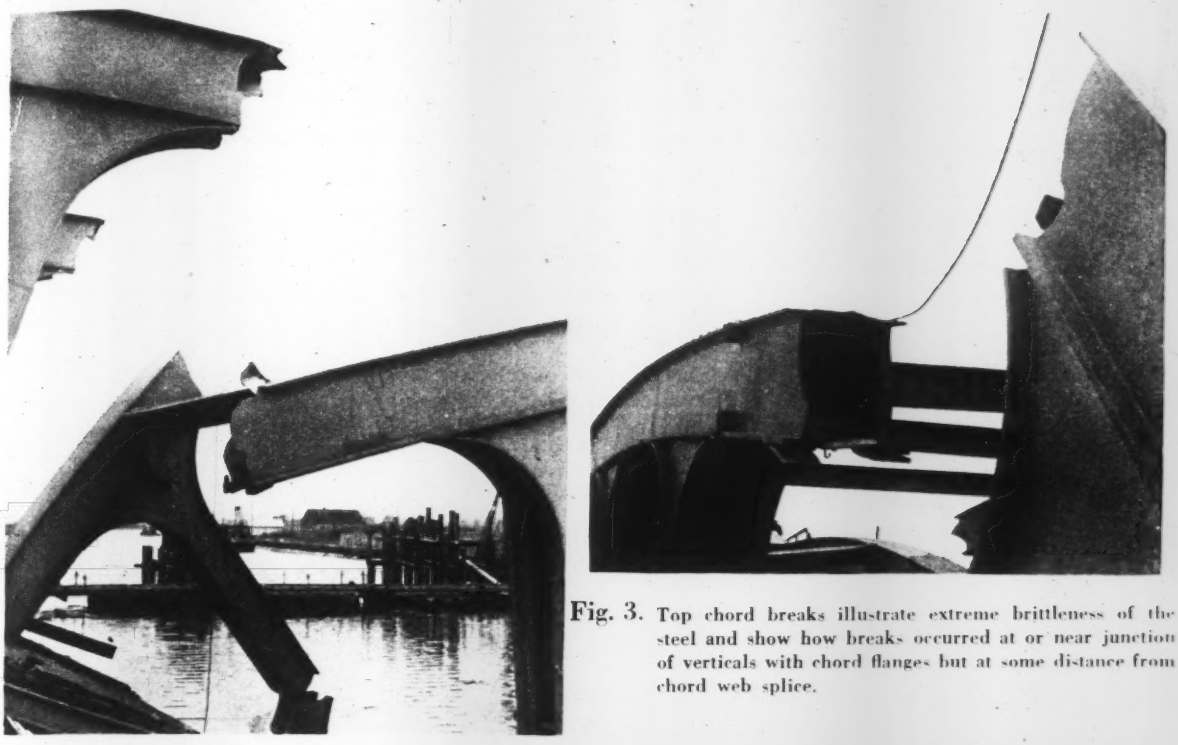

Fig. 3. Top chord breaks illustrate extreme brittleness of the steel and show how breaks occurred at or near junction of verticals with chord flanges but at some distance from chord web splice.

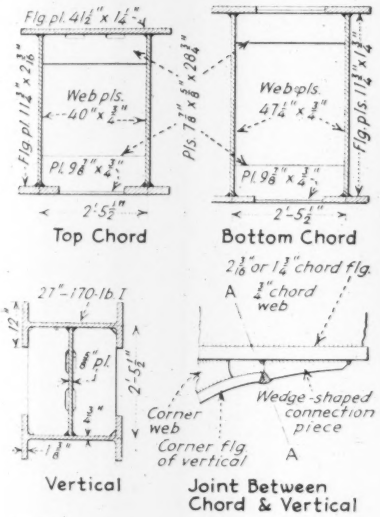

Fig. 2. Structural details of Hasselt bridge members. Numerous fractures occurred along line AA.

Fig. 4. Bottom chord fracture near splice does not involve welds. This break may have occurred from impact of bridge striking the towpath.

0.15, and sulphur and phosphor not more than 0.03 each, so that there should not have been unusual difficulty in arriving at satisfactory welds. Nevertheless, the fractures, whether in the welds, near the welds, or in parent metal, show exceptional brittleness of the steel. It has been claimed that this brittleness was due to the influence of heat introduced by welding, but this could hardly explain the brittleness at fractures several feet away from the welds.

Examination of the fractures

Inasmuch as the bridge in falling struck the towpath on either side of the canal, this may have been the cause of a number of secondary fractures both in the chords and verticals. The vertical member which broke off quite near an erection weld (Fig. 3, left), was probably fractured in consequence of this impact.

In the upper chord fracture shown in this same illustration the brittleness of the steel is obvious (4 to 5 ft. from the web weld), while the deformation shown in the upper diaphragm plate that is bent up above the top flange suggests that some of the welds were stronger than the parent metal.

Regarding the fractures at the bottom flange joint of the top chord

(Fig. 3, left), the detail at this point, which is typical for all connections of verticals to chords, is shown in Fig. 2. It will be noted that wedge-shaped connection pieces were used to join the 12-in.-wide rounded corner plate of the verticals to the chord flange plates. There is no doubt that many fractures occurred exactly at the section A-A, where the butt weld had to be made between rigidly restrained ends, thus probably causing internal stresses of considerable amount.

Similar facts are confirmed by the appearance of the upper chord fracture shown in Fig. 3 right, although here the break in the bottom flanges is about 18 in. from the wedge-shaped connection piece.

In the view of the lower chord of that part of the bridge which dropped to the embankment opposite the Hasselt side (Fig. 4), it will be noted that the failure in the near-side flange occurred about 4 in. away from the welded cover strap. It will also be noted that this crack started at the corner where the batten plate joined the flange and produced a notch effect. In the far-side flange, the crack is directly across the cover plate. In both flanges the appearance of these cracks seems to indicate that the welds were at least as good as the parent metal. The big crack in the $^{3}/_{8}$ in. thick web plate of 4 ft. depth occurred at a considerable distance from the web weld, the latter being indicated by the marks of cover straps which were only used for erection purposes and taken away after welding.

Some of the conclusions which seem to be warranted from a close inspection of the collapsed steel work are as follows:

Design

It may be assumed that the bridge was carefully designed, both as a whole and in its details, based on the experience with more than 50 long span Vierendeel bridges. Nevertheless, the arrangement of the upper wind bracing (which consists of rolled steel beams welded at the panel points between the upper chords by means of vertical gussets) appears to need some explanation as it could not act as wind bracing, but only as a stiffening strut to resist buckling of the upper chords. As a detail of doubtful reliability, the joints between the curved plates of the verticals and the flanges of the upper and lower chords may also be mentioned. These joints were no doubt centers of stress concentrations, and many fractures occurred in their immediate neighborhood. Perhaps, with a certain additional cost, erection welds might have been transferred outside this danger zone.

Assembling and erecting

It is obvious from an inspection of the bridge that the assembling was not as correct as it should have been. Examination of the lower wind bracing and the joints between the cross girders and the lower chords indicates that the welders were expected to make up for lack of alignment. As a consequence, it may be assumed that force had to be applied when assembling individual parts for welding, which may have introduced initial stresses.

Brittle steel

The St. 42 steel was supposed to have an elongation of 22 per cent on a gage length of 5 diameters but, it is understood, there were difficulties in obtaining the necessary elongation with the thicker plates. There can be little doubt regarding the poor quality of the steel; the fractures throughout are more similar to those usual with cast iron or even porcelain than to those which would have been expected with mild steel. It must not be overlooked, however, that only the initial failures in the bridge occurred under static load, while most of the other fractures were due to impact during collapse. This fact may at least partly explain the extremely brittle appearance of the fractures, and in a recent publication (A. de Marneffe, *L'Ossature Metallique*, Brussels, June, 1938) the distribution of bending moments due to impact during the collapse has been investigated. There is also a possibility of internal stresses having been in existence from the rolling process.

Welding

In fairness to the steel material it must be said that many of the welds which could be inspected by the writer were of very poor appearance, and would not have been accepted as complying with any of the modern structural welding specifications. Some of the welds showed very irregular surfaces, lack of penetration and undercutting. Apparently heavy gage electrodes were used, 5/32 in. for the first run and 13/64 and 9/32 in. for the following runs. This may have been another danger source, leading to accumulation of stresses. An unusually large number of erection welds had to be made on the site, and many of these welds were placed in danger zones.

Certain defects in welded bridges have been noticed in previous cases (Prof. E. Francois, *L'Ossature Metallique*, May, 1938), and it is known that considerable shrinkage stresses have been introduced by welding, resulting in one case even in raising one end of a Vierendeel truss bridge about 1¼ in. above its bearing.

From another source (H. Gerbeaux, *Revue de la Soudure Autogene*, Paris, April, 1938) it may be gathered that there has been some doubt regarding the reliability of welding in the case of the Belgian bridges generally.

It is probably correct to say that an unfortunate combination of a number of factors was responsible for the collapse of the Hasselt bridge, and the only conclusion it holds for the future may be to concentrate more and more attention on the scientific investigation of influences.

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11,000,000 in U. S. Under Council Manager Rule

More than 11,000,000 people live in cities now under the council manager plan of government, the International City Managers' Association has reported. An even dozen cities adopted the plan in 1937, ranging in size from Jacksonville Beach, Fla., pop. 1,094, to Alameda, Calif., pop. 35,033, according to the Association's new directory.

The 447 cities and 7 counties under the council manager plan in the United States are in 38 states. Michigan has the largest number: 46; while Florida, Virginia, Texas, California and Oklahoma have 30 or more apiece. Ohio lists 23 council-manager cities; Pennsylvania, 22; Iowa, New York, Kansas, Maine, Georgia and North Carolina have from 10 to 20 manager governments; and 24 other states from one to ten.

Tailor-Made Cofferdams

Sections of arch-web sheetpiling cut to fit bedrock contours, and welded to structural steel framework, are lowered from barges to form bases for Deer Isle suspension bridge piers in Maine

FACED with the problem of building and holding two 28x60-ft. cofferdams in 50 to 75 ft. of open water with only shallow cover over bedrock, the Merritt-Chapman & Scott Corp., substructure contractor on the Deer Isle-Sedgwick suspension bridge in Maine, turned to unconventional and ingenious cofferdam methods. The main pier bases are deeply submerged solid concrete blocks, surmounted by twin 14-ft. circular concrete shafts that extend 25 ft. above water. There is a heavily-reinforced distribution block, 10 ft. high, resting on top of each pier base.

Specifications required that the pier base be encased in steel sheet piling. Instead of inclosing the entire pier area with steel sheeting extending above high water, as is customary, the contractor conceived the idea of dredging and jetting the rough, steeply sloping pier sites to clean rock, then setting prepared sections on the bottom. Concrete in the base blocks and distribution slabs could be placed by the tremie method, but the concrete in the circular shafts had to be placed in the dry. Here, again, the contractor resorted to ingenuity and embedded a flanged nipple—if a 5-ft. section of 14-ft. pipe can be called a nipple—in the slab concrete, then fastened the circular form to the nipple, pumped out and concreted in a dry form.

Piers 4 and 5 are the main piers carrying the suspension towers. They are similar in size and design, except for depth under water. The base sections are 28x66½ ft. in plan. Rock at Pier 4 varies from El.—44 to El.—62 (mean sea level El. 0.0); top of base section is at El.—25, giving a base height varying from 19 ft. to 37 ft. At Pier 5 the rock varies from El. —66 to El.—78. The top of this base is at El.—43, resulting in a base height from 23 ft. to 35 ft.

On top of each base is a square-end dumbbell-shaped distribution slab 10 ft. thick and 24x56 ft. in overall dimensions, consisting of two 17x24-ft. sections connected by a 12-ft. cross tie. Surmounting each slab are twin 14-ft. circular concrete shafts that extend to El. 25. Specifications required that the shafts be encased in ½-in. wrought iron shells from El. —8 to El. 8 to protect the concrete at the waterline. Connecting

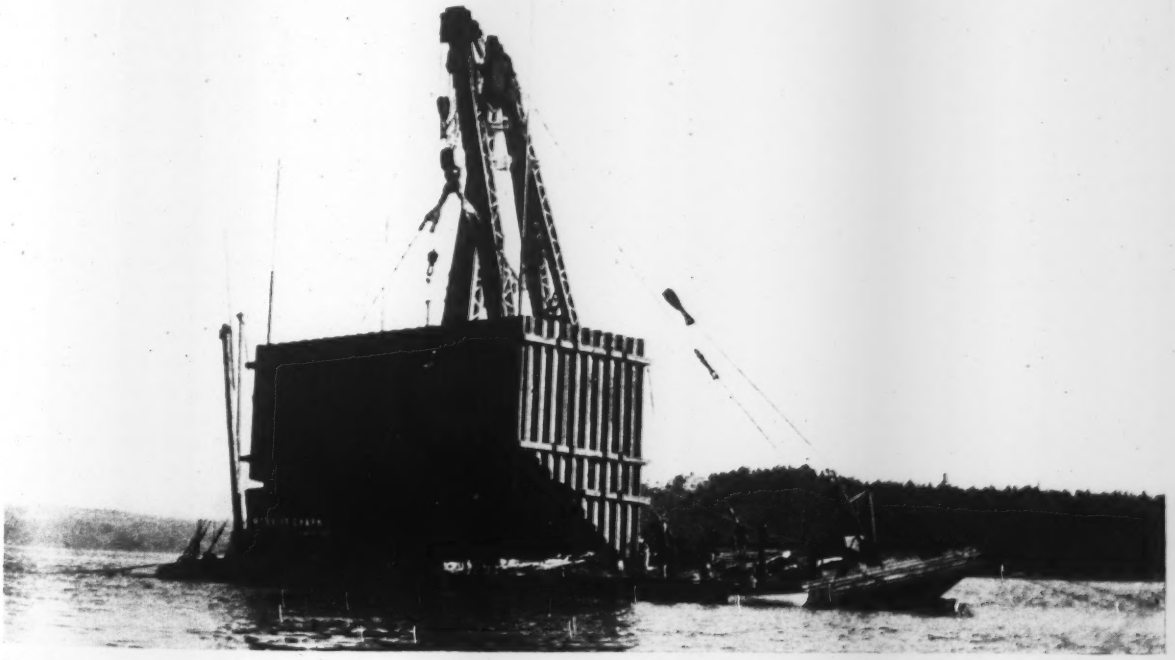

Fig. 1. Neatest trick of the season. Cofferdams for submerged pier bases on Deer Isle Bridge were built up of sheet piling and steel framing, trimmed to fit bedrock contours and dropped to place by a huge floating derrick.

the tops of each pair of shafts is an arched tie 10 ft. wide and 10 ft. minimum depth.

Cofferdam preparations

The first step in preparation of the pier sites was to remove the 6 to 14 ft. of overburden, by clamshell dredging, well beyond the limits of each pier. Dredging was followed by pressure jetting to sweep the exposed rock clean. Inspection by a diver revealed an exceptionally good bottom, though rough and sloping toward the center of the waterway.

The locations of the four corners of each pier were marked by heavy dowels, and wires strung between dowels outlined the perimeter of the base.

Accurate contours and profiles of each pier site were obtained with the aid of a "plumb bob"—not one of a weight and wire, but an 80-ft. lattice steel derrick boom weighing 8 tons, swung from a floating derrick. A level rod was fastened to the upper part of the boom, and readings were taken from shore by both stadia and levels. Reading from shore eliminated any errors due to rough water or a 10-ft. tide range. Soundings and corresponding readings were made over both sites on 5 ft. grids, and along the perimeters at 1-ft. intervals. From these readings the exact profiles of the perimeters were drawn.

Fabrication of cofferdams

The cofferdam boxes were fabricated at the contractor's yard at New York, put on barges and towed to the job. Arch-web steel sheetpiling, of 27-lb. section, formed the outer skin of the boxes, the sheets being set vertically with their tops in a level plane. Interior bracing consisted of two complete tiers of horizontal trusses, set 16 ft. apart, and one part frame in the lower section to brace the deep side. Trusses were made up of 10-in. beams and channels for main framing, braced by 10-in. ship channels. The two tiers were diagonally braced by ship channels. On the outside, at corresponding elevations of the interior trusses, were horizontal 10-in. steel beam wales, bolted through the sheeting to the inside framework. All framework was fabricated by bolting, and the pile sheets were fastened together by 6-in. welds about 1 ft. above the lower tier of bracing.

When assembled and blocked up on a barge at the site, the lower edge of the cofferdams were cut away to the exact profile as determined by the soundings. At the inside corners of the trusses were placed four adjustable steel spuds designed to act as supports for the box when lowered in place. Installation of lifting toggle hooks in the top tier of bracing and assembly of an eccentric four-line lifting sling completed the fabrication of the sections.

Completely assembled, the cofferdams weighed some 135 tons each, which were fairly easy loads for the *Monarch*, one of Merritt-Chapman & Scott's 250-ton floating derricks. In fact, this method of foundation procedure would have been impossible had the heavy lifting derricks not been available.

The barge carrying a cofferdam was spotted directly over the pier site with the derrick anchored alongside. Range poles were set at either end of the box to permit lining in from shore for exact setting of the cofferdam. Then with a high boom and side lift, the derrick lifted the load free of the barge, which was towed out from under, and the cofferdam was slowly lowered to its final resting place. The cofferdam for Pier 4 fitted perfectly; that for Pier 5 hung up on a rock projection not revealed by the soundings, necessitating raising the box and burning away a short section of the lower rim.

To insure a tight seal, a row of bags of dry-batched concrete was placed by a diver along the outside toe of each cofferdam. The base sections were then filled with tremie concrete in continuous pours of 1,785 cu. yd. each. Concrete was mixed in a floating plant and deposited from a tower hopper on the same barge through sectional spouting.

Distribution slabs and shafts

Steel forms for the 10-ft. thick distribution slabs were also fabricated at New York. The forms were braced with five tiers of horizontal trusses, designed in such a manner that 10-in.

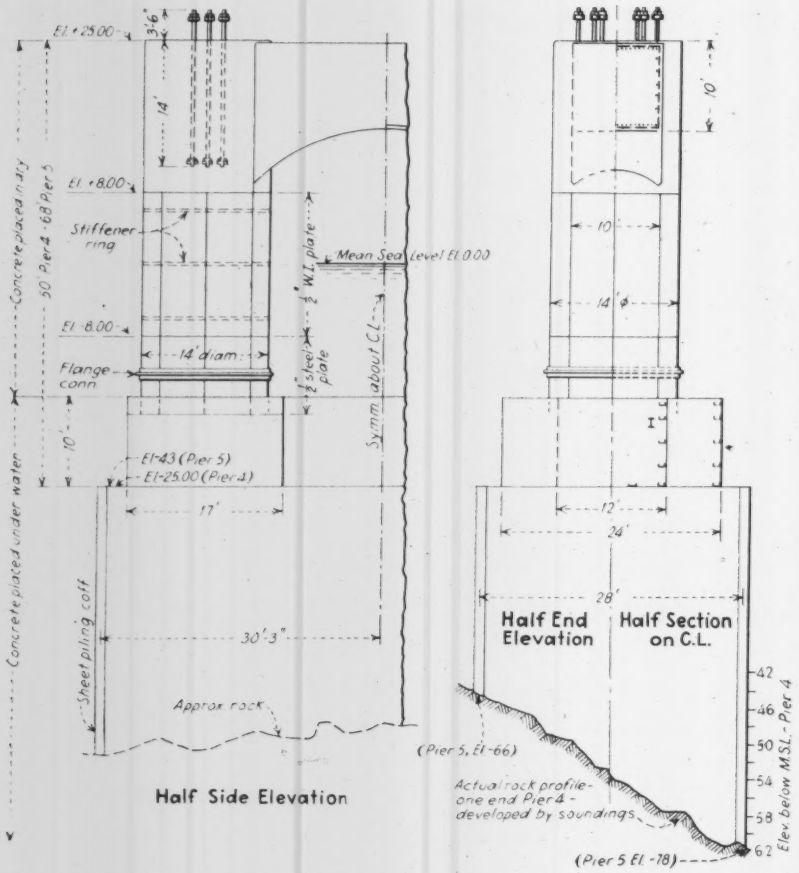

Fig. 2. Design features of the main piers include submerged bases, heavy distribution slabs, wrought-iron encased circular shafts and deep arch cross-ties.

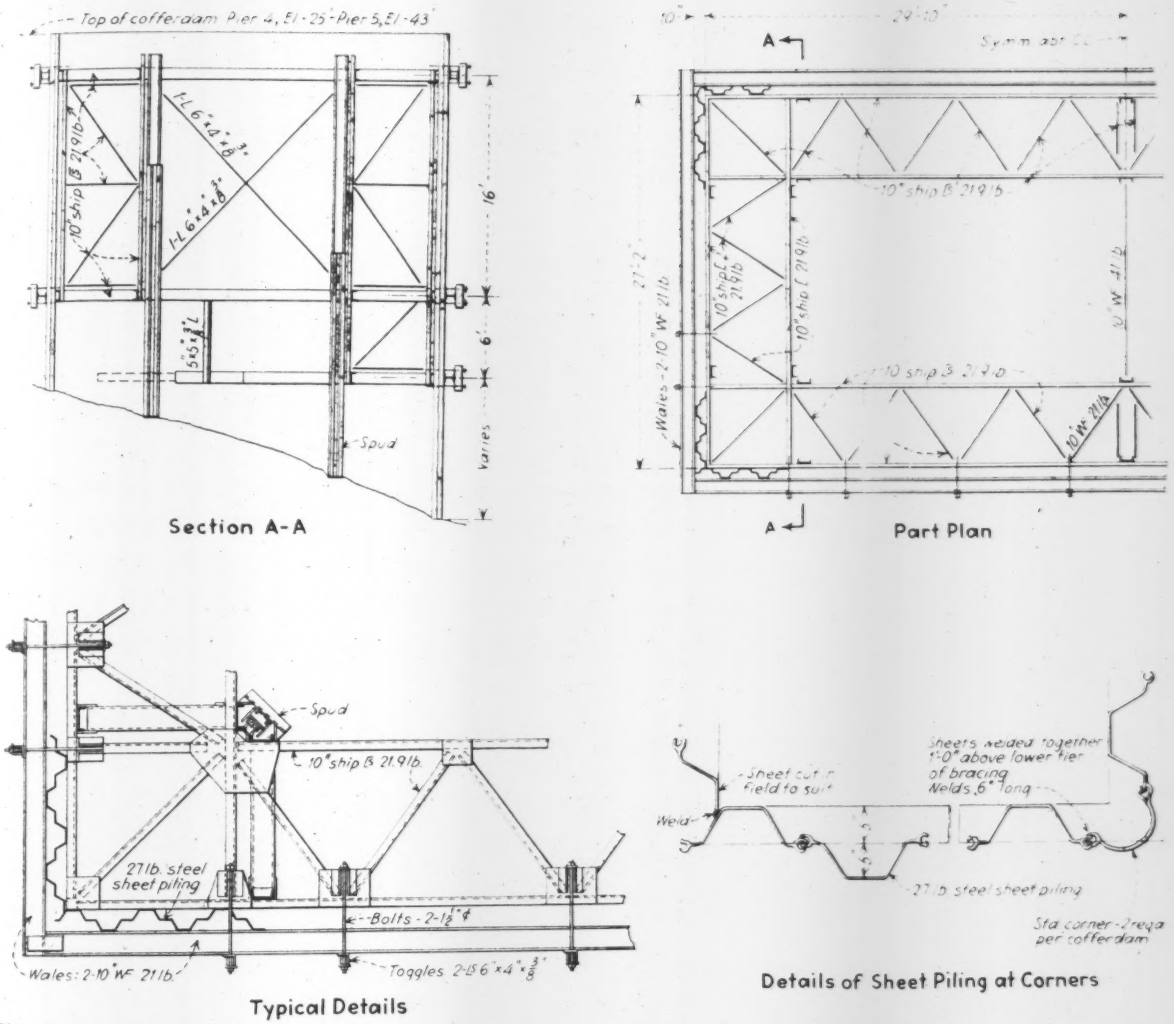

Fig. 3. **Details of the tailor-made cofferdams. Completely assembled, the arch-web sheeting walls, beam and channel truss bracing and the four spuds for landing, made a load of 135 tons for the derrick.**

channels took the place of heavy bar reinforcing called for in the plans. At the location of the 14-ft. circular shafts, the short nipples of 14-ft. pipe, flanged at the top, were framed into the steel formwork, extending 3 ft. above the top of the slab. Concrete for the slabs was also placed by the tremie method. The forms and reinforcing for each slab weighed 30 tons.

Plans called for wrought-iron encasement of a 16-ft. length of shaft at the water line. The contractor fabricated the wrought iron as a 14-ft. pipe, well braced with interior rings of angles. To complete the forms for the full height of shaft from the distribution slab to the cross arch, steel pipes were added to the lower end of the iron sections, flanged at the bottom to connect with the nipples already in place.

When the shaft forms had been securely bolted through the flanges to the nipple sections, the interior of each pipe was pumped out, providing a dry form extending from 25 to 43 ft. below water to 8 ft. above. Bar reinforcing was placed within the pipes and concrete poured as for any column on dry land.

Well-built forms

Formwork for the shafts above the iron-bound section and for the heavy cross arches was fully designed and detailed in the contractor's main office and fabricated at the New London yard. The arch forms were carried on four steel columns extending down to the steel grillage on the distribution slab far below water level. Four I-beams between column bents supported the arch form.

The contractor's engineering department designed and detailed every cofferdam and form item for the complete job. Construction plans were not mere sketches, but were complete drawings to scale for every detail. The field forces had only to assemble the fabricated sections. Reports from the job indicate the advance engineering work on the part of the contractor was well worth while.

Bridge history and design

The design of the bridge is fairly simple, as far as suspension bridges go. The main bridge is 2,048 ft. long, consisting of a center span of 1,080 ft. and side spans of 484 ft. each, stiffened with 6½-ft. plate girders. The anchorages are 130 ft. beyond the ends of the suspended spans, two

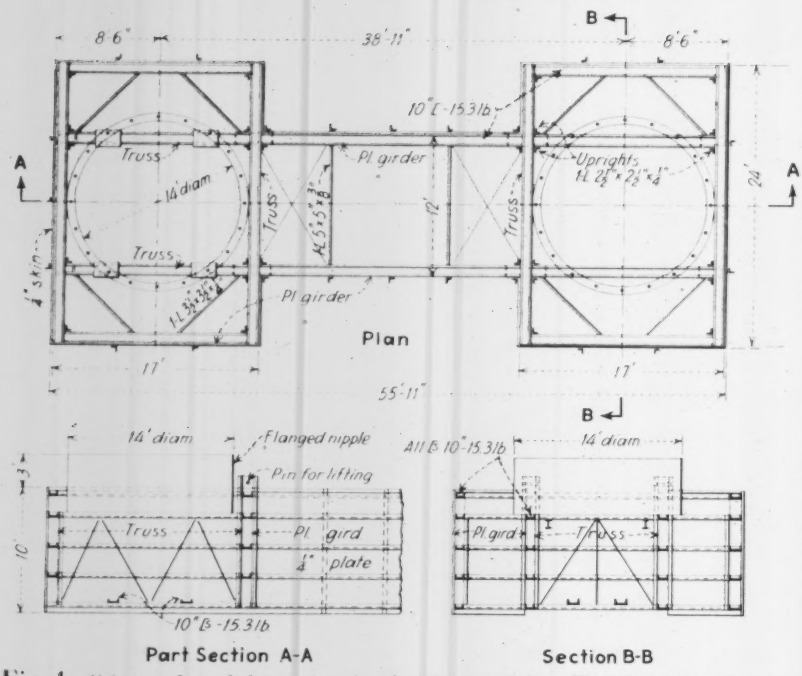

Fig. 4. Fabricated steel forms for the distribution slabs. The channel and truss bracing of the forms was utilized as concrete reinforcing.

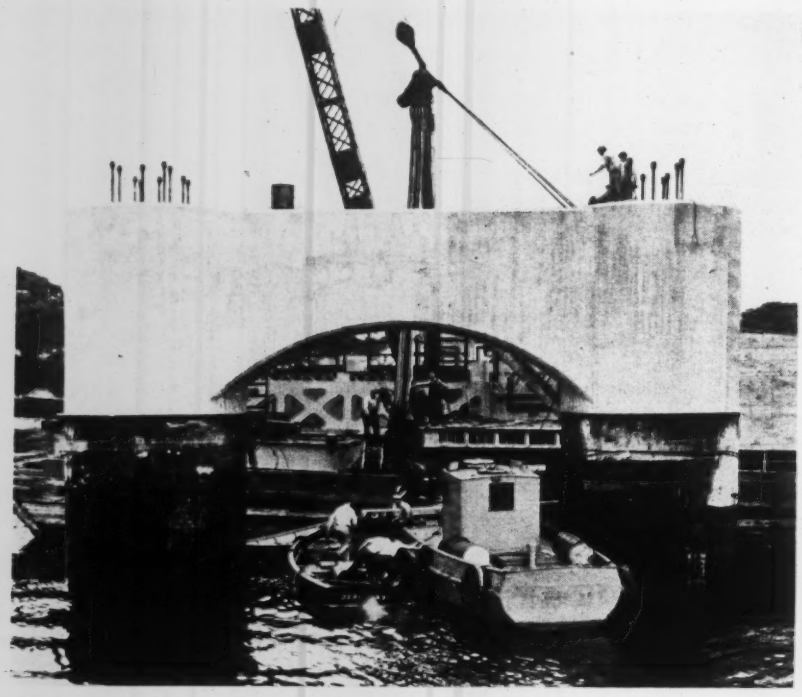

Fig. 5. A finished pier ready for steel work. Note the wrought iron protection on the circular shafts extending almost to the bottom of the arch.

cable bents on shore carrying the cables and approach superstructure between each anchorage and corresponding suspended arm. Steel towers 185 ft. high above top of masonry piers carry two 7½-in. parallel-strand cables, 23½ ft. apart. The floor system consists of 24-in. 74-lb. beams, 7 ft. c. to c., supporting a 20-ft. concrete roadway of 4½-in. thick, reinforced with longitudinal truss bars.

For years there have been plans for a bridge across Eggemoggin Reach connecting Sedgwick, on the mainland, with Deer Isle. Final plans provided for a bridge between the mainland and Little Deer Isle, and a causeway connecting the two islands. This latter structure was built some time ago.

Financing of the main structure is of interest. The project was originated by local Hancock County interests which set up the Deer Isle-Sedgwick Bridge District. State aid was sought, resulting in the formation of a joint board including the bridge district trustees, the state highway commissioners and the commissioners of Hancock County.

Robinson & Steinman, consulting engineers of New York, were called in to prepare the plans. Meantime, the district had sold bonds aggregating $490,000, and had secured a PWA grant for $315,000, making a total of $847,000, including the bond premium available for financing. This limiting amount was fixed by legislation and was based on a preliminary estimate made in 1933 before borings and surveys were completed. There was no leeway to cover the substantial rise in construction costs at the time of financing in 1936.

The first plans called for a bridge of 1,600 ft. suspended length—a center span of 800 ft. and two side spans of 400 ft. The two main piers were 75 ft. and 125 ft. deep, and foundation difficulties were feared by bidders.

Separate bids for foundations and superstructure were opened Nov. 12, 1936. The lowest superstructure bid and a single wild bid for the substructure totaled $1,123,198, far more than the money available. Another substructure bid, later revealed as 50 per cent lower than the sole proposal received, was lost in the mails and arrived too late for the opening. Plans were revised slightly, but bids opened on Feb. 11, 1937, ran $836,524, still somewhat too high for the money available. Again the foundation plans were altered, but the new substructure bids, received Apr. 7, 1937, showed a saving of only $30,000 over previous bids. All bids were then thrown out as not leaving enough for contingencies.

Prices were beginning to rise steeply, and the resulting increase in the cost of the project during the next few months was $160,000. Studies indicated that lower bids could probably be obtained by lengthening the span and thereby shifting the deepest of the two main piers to more shallow water. This was done, lengthening the main span from 800 ft. to 1,080 ft. and the suspended structure from 1,600 ft. to 2,048 ft.

To help make up for the intervening increase in construction costs, the Governor's Council of the state appropriated $140,000, bringing the total available funds to $870,000. New bids were opened Nov. 2, 1937, and the low proposals of $358,765 for the foundations and $459,850 for the superstructure were well within the allotted funds, leaving $42,000 for contingencies.

The substructure work is now complete, and steel erection is under way by the Phoenix Bridge Co. According to schedule the bridge will be opened early in 1939.

Direction

Raymond C. Small is secretary of the Deer Isle-Sedgwick Bridge District Trustees, and L. D. Barrows, state highway engineer, is secretary of the joint board. The structure was designed by Robinson & Steinman, consulting engineers, New York, with R. M. Boynton in charge of design and D. G. Letourneau resident engineer at the job. Frank Slane, senior engineer in charge of New England, represents PWA.

For Merritt-Chapman & Scott Corp., substructure contractor, Frank W. Barnes, construction manager, R. E. De Simone, New England district manager, and Wm. Denny, superintendent, were in charge. Al Siecke, office engineer, supervised the engineering for the contractor.

Soundproof Studios for the Movies

CYRIL PROVO HUBERT

Structural Engineer, Loew's Inc.—Metro-Goldwyn-Mayer Pictures, Culver City, Calif.

Methods and materials used in sound stage construction for the motion picture industry of Southern California

THE STRUCTURAL requirements of soundproofed stages, acoustically adapted to making motion pictures with sound, have brought the structural engineer many problems. New light having been thrown on these problems in the last few years, recent construction embodies improved practices and advanced technique. In the following is presented a brief outline of some of the recent studies, the methods and materials used and structural design features that have been developed for a group of very large sound stages recently built by the Loew's Inc. studios at Culver City, Calif. The methods described are typical of those generally followed in the major studios of the West coast.

In undertaking the design of soundproof stages the structural engineer is confronted with the essential requirements of recording sound within an enclosed space. Not only must there be effective barriers to foreign sounds but resonance or echo within the enclosed space itself must be controlled. These two needs have to be dealt with separately: excluding foreign sounds is sound insulation; preventing echo is sound absorption.

There are two methods of insulating against sound. The first is mass construction using a homogeneous mass of heavy masonry. In this case the insulation value is proportional to the logarithm of the weight of the mass or its thickness. Reduction of sound transmission by increasing weight and density usually is not practicable in sound-stage construc-

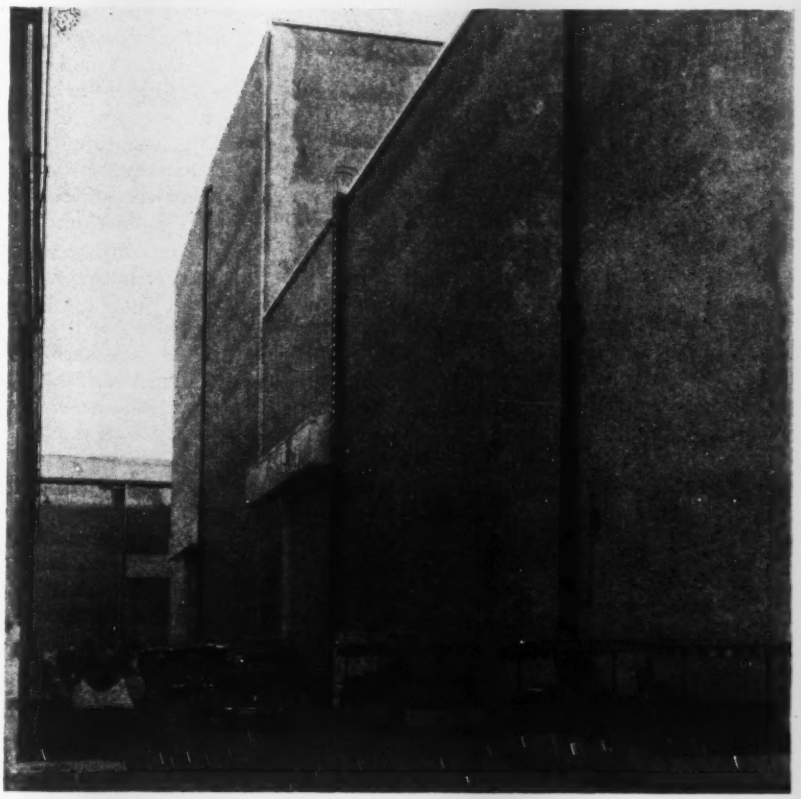

Fig. 1. Typical sound stage exterior. These structures, 240 ft. long, with a truss span of 136 ft. and a clear height inside of 80 ft., must be built to keep outside noises out and inside sound under control.

TABLE I—COMPARING SOUND INSULATING VALUES IN TWO TYPES OF WALL CONSTRUCTION

Frequency of test tone (double vibrations	Walls at left in Fig. 2 Value of sound insulation (decibels)	Walls at right in Fig. 2
128	53.2	65 or more
512	60.4	74.0
2,048	63.8	80.5

tion. The second method is to build up walls with alternate layers of hard and soft materials and interposed air spaces, i.e., laminated construction.

The importance of air spaces for isolating and controlling structural vibrations becomes apparent from the difference in velocity with which sound vibrations travel in air and in various building materials. In air, the velocity is about 1,100 ft. per sec. as compared to velocities of the order of 16,000 to 18,000 ft. per sec. in lumber, concrete, steel and glass. By alternating dense and semi-porous materials, the different sound conductivities tend to fatigue sound waves and hence to retard or entirely prevent their penetration.

Sound-proofing problems

Before deciding upon the design of the new soundproof stages for Loew's Inc. studios, Vern O. Knudsen, of the University of California at Los Angeles, was retained to conduct a series of tests of sound-insulating values and, more particularly, to obtain specific information relative to the sound-deadening qualities of various building materials in combination with one another. For these investigations a test chamber or room was built on the studio premises in the form of a room inside a room and with no connection between the two except through the ground. The inner space was 10x10 ft. in plan and 8 ft. high; an air gap 2 ft. wide was left between the inner and outer structures. Access to each structure was through a heavy wood door around which soft rubber strips were so placed that when the door was closed it was jammed against the rubber.

Tests were aimed at determining the sound insulation values of outer and inner wall structures separately and jointly. Measurements consisted of determining the attenuation of sound transmission through the wall. A test tone on the outside was reduced until it was just barely audible within. A measure of the insulation provided by the wall was obtained

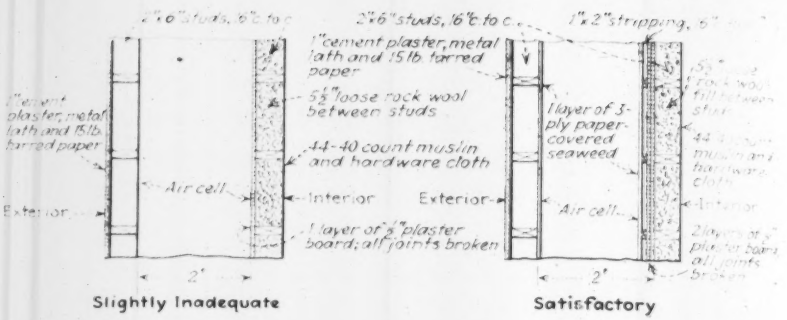

Fig. 2. Two wall designs used in test chamber which gave sound insulation effects shown in Table I.

by comparing the loudness of the test tone and the loudness of the sound just barely audible on the opposite side of the wall. Measurements of attenuation were made with test tones of different frequencies, namely 128-, 512-, and 2,048 double vibrations (d.v.) per second.

The decibel value (decibel is the unit of measurement employed in comparing the relative intensities of sounds) is ten times the common logarithm of the difference in their vibrational energies. This difference is usually expressed as "energy reduction" and hence the unit of measurement or decibel is the "energy reduction factor." For example, a reduction of 1,000-fold in sound vibration energy is exactly described as a sound intensity decrease of 30 decibels because the logarithm of 1,000 is three and, by definition, the value in terms of this unit of measurement is ten times the logarithm.

In Table I are given the results of tests on the test chamber construction shown in Fig. 2. The insulation value of the left wall was not quite enough, and resistance to sound vibrations was increased by a change to the design shown at the right. In general, results with the latter construction were quite satisfactory and indicated that it would provide a high degree of insulation for sound stages. It is to be noted that the insulation at 128 d.v. was more than could be measured with the available apparatus. However, from measurements on the outer and inner walls separately it is believed that the insulation to 128 d.v. sounds is about 67 db.

The tests were primarily of a comparative nature. The practice is to provide more insulation than would be indicated by measurements made in the small-sized test chamber. This is because walls of large structures, when subject to sound waves, act more or less as elastic diaphragms secured at the edges; the larger the unsupported wall area the greater the intensity of the transmitted vibration. In other words, sound insulation value varies inversely with the size of the unsupported panel.

It is important not to overlook the need for breaks in the structural continuity of walls, floors and ceilings. These should be put in to minimize the sound-carrying vibrations that originate and progress in the structure itself as the result of exterior, air-borne noises.

Minor details of major importance

Stage floors must not be rigidly connected to the wall structure; they should be insulated from the remainder of the building to avoid transmission of ground noises (such as those caused by trucks) and horizontal vibrations generally. For this purpose strips of soft fiberboard are placed around the edge of the floor frame, for its entire depth, next to the side walls.

Typical details of soundproofed construction are shown in Fig. 3. Where a single wall intervened between adjoining stages very unsatisfactory results developed when a single centrally located column served both stages, hence modern construction entirely separates the structural frames for two sound stages.

In laminated wall construction, plaster applied forcibly under air pressure proved to be a far better sound-insulating medium than plaster placed by hand; probably because of the greater density of the former. The latter quality was proved by an air-pressure test made as follows: Two plaster areas were subjected to the same air pressure for a given

TABLE II — COMPARING SOUND INSULATING VALUES OF DIFFERENT MATERIALS*

	Test tone frequencies	128 d.v.	512 d.v.	2,048 d.v.
		Energy reduction factors in decibels		
½-in. mineral wool (Paper each side)		15.8	21.0	21.8
½-in. mineral wool (Covered with heavy tarred waterproofed paper)		16.1	21.0	23.2
½-in. plaster board		24.3	31.3	28.1
½-in. industrial soft insulation board		15.0	21.0	26.0

* Products from different manufacturers vary with the density.

TABLE III — RESULTS OF SOUND ABSORPTIVE TESTS ON MINERAL WOOLS

	Test tone frequencies	128 d.v.	256 d.v.	512 d.v.	1,024 d.v.	2,048 d.v.
		Coefficients of sound absorption in decibels				
1 -in. mineral wool blankets		37	51	65	82	85
1½-in. mineral blankets		39	54	67	83	85
2 -in. mineral wool blankets		46	61	70	84	86
4 -in. mineral wool loosely packed between 2 x 4-in. studs 16 in. c. to c.		48	53	58	65	70

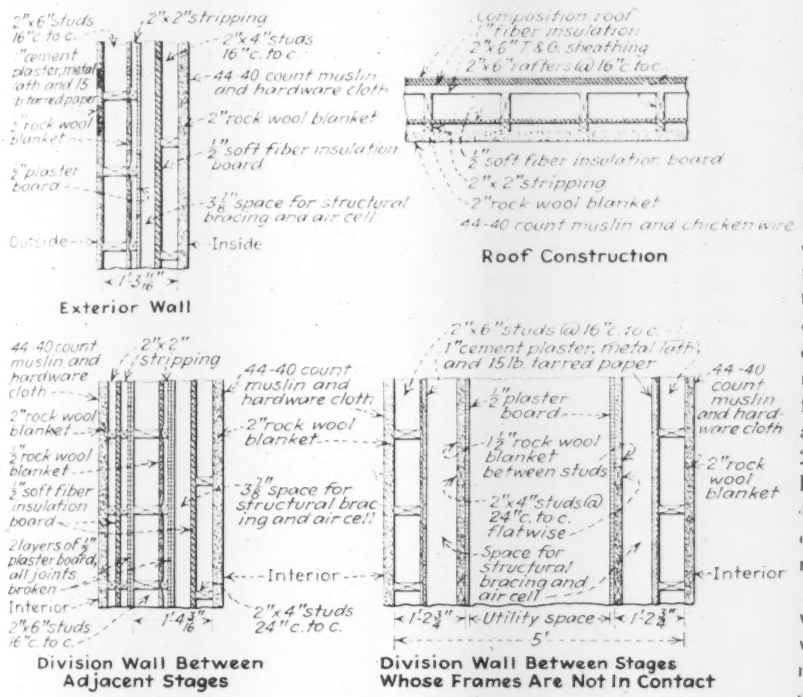

Fig. 3. Typical wall and roof construction used in latest type of acoustically-treated sound stages.

period and the quantity of air passing through the plaster was measured. In one case a portion of a brick wall was covered with a ½-in. layer of plaster applied by usual hand methods. In the second test area ½ in. of plaster was propelled forcibly by compressed air against a temporary backing that was removed when the plaster was ready for test. Thus, brick support during the test obtained only for the hand plastered area. Air pressure of 40 lb. per sq. ft. was applied to the two areas and maintained for one hour. In this time 115 cu. ft. of air passed through the hand plastered section and only 1 cu. ft. went through the plaster put on by air pressure.

The exterior wall section shown in Fig. 3 has the inner face of the exterior studding backed up with ½-in. plaster board. This puts two hard surfaces adjacent to each other and results in a slight loss in soundproofness. This loss was conceded to permit backing up the inner stud adjacent to the 2-in. rock-wool acoustical treatment with a soft board that would eliminate cavity resonance or false harmonics which might obtain if a hard surface were applied back of the acoustical wool.

Experience with sound stages indicates they can be used to full advantage if sound transmission through the walls is curtailed by a sound insulation value of 55 to 70 db. at 512 d.v. No attempt is made to cope with sound levels above 72 db. Most of such sounds are intermittent and hence not serious since a small percentage of the working day is used in actually filming scenes.

There is a certain time of reverberation that will produce best results with any given stage. From actual tests at 512 d.v. the optimal time of reverberation was found to vary from 0.75 to 1.00 sec. according to the size of the stage. Long usage has established the custom of computing reverberation periods at the 512-d.v. frequency. However, consideration should be given to the absorption coefficient at other frequencies, especially 128 d.v.

To obtain the optimal acoustical quality, interior walls and ceiling must be treated with materials that are not only highly absorptive but also uniformly absorptive throughout the important range of frequencies employed in speech and music.

Mineral or rock-wool has been found highly satisfactory in acoustical absorption because of its almost flat character throughout the important frequency range. Table III indicates the results of tests made to determine sound absorption values of mineral wools selected at random from the various manufacturer's test analyses. The mineral-wool blanket 2 in. thick (Table III) is now used by Loew's Inc. studios in lieu of the 4-in. wool pack because the settlement of the latter over a period of time reduces the adsorptive value.

Many motion picture sets have three walls and, in effect, become a stage within themselves, thus making it necessary to provide for passing the sound bodily through the set to the treated walls and ceiling of the stage proper. This calls for the elimination of all hard wall sets and the construction of sound sets to meet acoustical requirements on the same basis as the stage proper. In the Loew's Inc. studios all smooth wall sets consist of dyed muslin stretched on wood frames.

Structural framing

Five new sound stages were recently constructed for the Loew's Inc. studios. These include one two-stage and one three-stage unit. In the largest of these the truss span is 136 ft.; there is a clear height of 80 ft. under the trusses for one-half the stage length and 50-ft. clear height for the remainder. The overall length is 240 ft. The latest uniform building code was used as the basis for design of the structures, in which the usual California allowances for horizontal

forces (earthquake resistance) were made. For the latter, the forces were distributed by horizontal trusses in the plane of the upper chords to the exterior walls and thence by diagonal bracing to the foundations. The steel skeleton design took advantage of the 1936 revised secifications of the American Institute of Steel Construction, which increase the basic unit stress from 18,000 to 20,000 lb. per sq.in. These secifications became effective, under the uniform building code, the week that the design of these stages commenced, thus permitting a substantial saving in steel tonnage.

Because of the height of the walls the wind uplift on the anchorage had to be considered in the footing design. The code required that the over-turning moment resulting from wind conditions should not exceed 50 per cent of the dead-load resisting moment. Steel shear lugs 3x¾ in. x 2 ft. 3 in. long, welded to the base plates, were used to transfer horizontal column shear to concrete footing pedestals along the center wall columns.

Construction methods

All steel columns are of wide-flange sections; those 93½ ft. long, supporting the stage trusses at a clear height of 80 ft., are 24 in. wide and weigh 110 lb. per ft. The columns were butt-welded, and, since the sections are subject to combined bending and vertical loading, welded butt-strap splices were used. The wall construction was supported on double-channel spandrel beams 14 ft. on centers; wide-flange split I-beams were put in to connect the spandrel beams and diagonal wall bracing to the columns.

All diagonal wall bracing was designed to frame into a width of not more than 3½ in. in order to clear inner and outer wall panels. This necessitated flattening the rivet heads to a maximum thickness of ⅜ in. Air space between the inner and outer walls was limited to a width of 3⅝ in. because the building ordinance requires a sprinkler system between walls more than 4 in. apart. The laminated wall panels were constructed in units on the ground during steel erection and were lifted to position bodily. Air-applied plaster 1 in. thick, with metal lath and waterproofed paper backing, was then applied to the exterior, and a 2-in. acoustical rock-wool quilt with a 44-40 count flameproof muslin face and a 60-lb. building-paper back was applied to the inner studding. As a protection to the wool, double-mesh 19-gage galvanized hardware cloth was applied for a height of 16 ft. The remainder of the surfaces were covered with standard chicken wire. Wood wall-guards or rubbing strips were applied at 16- and 24-ft. heights around all inner surfaces of the stage walls.

Quick-setting cement was used in the concrete foundations to permit early erection of steel, and a special arrangement with the steel erector permitted the general contractor to apply all wood-bolting strips to the steelwork prior to erection. These bolting strips were insulated from the steel by composition stripping which made an effective separation of steel and timber frames.

In building these five sound stages, time was the essence of the contract because the noise incidental to construction interfered with the filming of exterior scenes. A careful advance study of the progress schedule was the basis for a construction program that could be completed in 18 five-day weeks. This plan was followed, and the work was completed two days ahead of schedule. The five stages include about 1,410 tons of structural steel and enclose 7,937,000 cu.ft. of soundproof building space.

Soundproof doors

In determining the insulation value of a soundproofed door, the limiting factor is tightness of the fit or seal of the door against the jamb. Thus far no method has been devised for sealing a single door in such a way as to produce insulation value equal to that of the wall itself. Hence a pair of doors with an intervening air space is necessary. The large service openings used for trucking in material and equipment are relatively simple problems because they can be closed and left closed when the time for filming a scene approaches. On the Loew's Inc. stages the service openings consist of two pairs of 18x 24-ft. soundproofed sliding doors for each stage. Operation is from the inside of the stage by means of monorail equiment of standard make. Simple clinching mechanisms manually operated from the inside control the sealing of these service doors.

Unlike the service doors, the 18x24-ft. pedestrian doors require very special treatment. Ordinarily there are two such entrances to each stage, each consisting of two soundproofed doors separated by a 5-ft. vestibule. Each door is equipped with a solenoid-operated clinching mechanism and roller-bearing hinges with an equalizing arrangement for application of pressure on the hinge side as well as on the latch side. Limit switches are used to prevent application of the operating current except when the doors are within range of sealing. Seals consist of specially designed two-density rubber contact striping.

For the pedestrian door mechanisms remote control at the camera is provided, and when this is operative there is no means for opening the doors from the outside. Panic bolts and latches however, are operative for opening the doors under any condition from the inside. The remote control at the camera also short-circuits all telephone bell boxes within the structure during the filming of a sound scene.

The five new soundproofed stages mentioned cost about $850,000 exclusive of power plant and equiment. Plans and specifications were prepared in the engineering department of Loew's Inc. studios by a technical staff which included William Koenig, studio manager; John M. Tobin, plant superintendent; J. G. Maver, head of purchasing department; Lou Kolb, mechanical superintendent and C. P. Hubert, structural engineer.

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Exhibit of Soil Corrosion Specimens

AN EXHIBIT to show the effect of corrosive soils on specimens of pipe and protective materials has been arranged in the Industrial Building at the National Bureau of Standards in Washington.

K. H. Logan, who is in charge of this work at the Bureau, explains that most of the specimens have been buried for four years in fifteen soils differing widely in their characteristics. These samples of pipe include several varieties of ferrous materials as well as copper, brass, and bronze. Soldered and brazed joints, protective materials, and pipe made of a composition of cement and asbestos are also represented.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Fitting a Parabola to Grade Tangents

LAWRENCE D. HERB
Bethlehem Steel Co., Chicago, Ill.

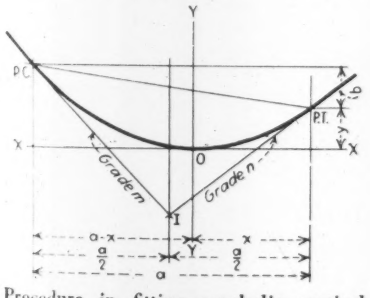
The following method of determining the elevation and tangent slope at any point along a vertical parabola will in most cases be preferable to the method of dividing the parabola into stations and substations as given in most text-books.

The general parabolic equation is $x^2 = 2py$ or $y = \frac{x^2}{2p}$. Differentiating $\frac{dy}{dx} = \frac{2x}{2p} = \frac{x}{p}$. As the value of the 1st derivative at any point on a curve is equal to the slope of the line tangent to that point, the value of $\frac{x}{p}$ is equal to the slope of any line tangent to a parabola at the distance x from its axis.

Given two grades m and n, the distance a between the points P.C. and P.T., and b the difference in their elevations, as shown in Fig. 1, locate the vertical parabola that will be tangent to the grades at the two points.

Moving from left to right on the curve the slope at P.C. is descending and minus $(-m) = \frac{-(a-x)}{p}$ and the slope at P.T. is ascending and plus $n = \frac{x}{p}$. Solving for p from these two equations $p = \frac{a}{m+n}$.

The distance x from P.T. to the axis of the parabola is found from the equations $x^2 = 2py$ at P.T. and $[-(a-x)]^2 = 2p(y+b)$ at P.C. Solving for x from these two equations $x = \frac{a}{2} - \frac{bp}{a}$. The elevation of the vertex of the parabola is found by substituting the known values of p and x in the equation $x^2 = 2py$ and solving for y.



Procedure in fitting parabolic vertical curves to crest or valley grade tangents.

With the vertex of the parabola located, any other point can be found from the equation $x^2 = 2py$, and its slope determined from the equation $\text{Tan. } \theta = \frac{x}{p}$. (Tan. θ equals the tangent of the angle between the tangent line and the horizontal.)

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Gravel-Packed Quicksand

R. F. MIRICK
Construction Supervisor of Sewers,
Killdeer, N. Dak.

Over twenty years ago I saw a contractor go broke fighting quicksand on sewer construction. Then another contractor came along and finished that job using a method we have patterned after in laying sewer tile here at Killdeer. This method is to gravel-pack the subgrade.

If the sand will carry a man walking through it, gravel of graded sizes ¼ in. to 1 in. is shoveled slowly into the sheeted ditch while a man treads back and forth tramping the gravel down into the quicksand. If the sand will not bear a man at first, then poles are used to stir the gravel into the sand until it will bear a man's weight. Treading on the graveled subgrade is continued while slowly adding gravel a shovelful at a time until the subgrade compacts and builds up to the required elevation. Subgrade built up in this way is now known to have stood up for more than 20 years.

In the more treacherous locations the sheeting is left in place when the ditch is backfilled, but generally it is possible to withdraw the sheeting after the trench has been gravel-packed and the tile laid. The space left by withdrawing each sheeting plank is tamped full of earth as the plank is pulled. Planks are not drawn until a foot of earth has been tamped over the tile.

Where gravel of the desired grades is difficult to obtain we use oversize from highway pits. Some of this gets to 3 in. in diameter. This big size is treaded down into the quicksand first, then as the subgrade begins to build up we use smaller and better-graded sizes. Our gravel-pack will average about 18 in. thick below tile grade. It would be much deeper than that in a quicksand so unstable that a man could not tread in it; where it is necessary to stir with poles it sometimes takes a 3-ft. or more layer of gravel-pack to support a tile line.

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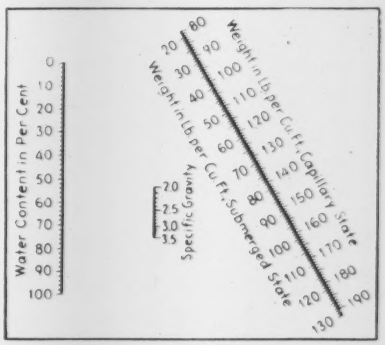
Chart Gives Soil Weights

WALTER E. COWAN
Consulting Engineer, Oak Park, Ill.

A nomograph giving the unit weight of soils having various specific gravities and moisture contents is submitted as a contribution toward closer approximation of loads on subsurface structures. In its preparation the usual assumption was made that the voids in a saturated soil are completely filled with water.



Scheme for nomograph for determining soil weights

The preliminary data required for finding the soil weight are the specific gravity and the water content (defined as the ratio of the weight in a sample to the weight of dry material) of representative samples. Both of these values are easily found by well standardized methods and the chart will show the corresponding weight if a straight line is passed through the given values and extended to an intersection with the inclined scale. Two weights are indicated: the capillary state includes the weight of the contained water and is used where the soil although

saturated is above ground water level; the submerged state is for use with soil below the ground water level and allows for buoyancy. In the event the weight of dry soil is required one need only divide the capillary weight by

$$\left(1 + \frac{W}{100}\right)$$

For approximate results average values of specific gravity may be used as follows: silt 2.50 to 2.75; sand 2.65 to 2.75, and clay 2.65 to 2.80. The weights obtained by use of the above values will usually be close enough for all practical purposes.

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Design of Timber Splices

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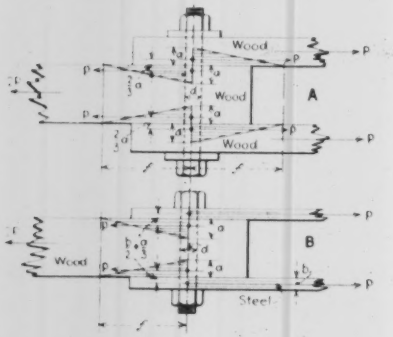
The formulas given here have been found timesaving in designing timber splices. They are based on the assumption that the maximum bearing will occur at the adjoining surfaces and that the stress distribution diagram is triangular with a base length a fixed by the resistance of the bolt against bending, and a height f equal to the allowable bearing value of the timber. The values obtained by these formulas will give conservative results. If the stress at the point has been accurately computed the values may be increased by one-third.



In the formulas: f is the allowable bearing on wood in lb. per sq.in.; d is the diameter of the bolt in inches, and R is the resisting moment of the bolt in inches cubed. The forms of splices are shown by the accompanying sketches.

Case I—Joint with wood splice pad, sketch A: The formula is:

$$P = \frac{fd}{2}\sqrt{\frac{3R}{fd}}$$

Case II—Joint with steel straps, sketch B: The formula is:

$$P = \frac{fd}{2}\left(\sqrt{\frac{6R}{fd}} - 3.4b\right)$$

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Areas of Parabolic Segments

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The determination of the area of a parabolic segment is sometimes of importance in the design of parabolic arches or the computation of quantities in arches and roadways. Now the area of a symmetrical segment cut off by a chord perpendicular to the axis of the parabola is two-thirds the product of the length of the chord by its distance from the vertex. However, it is often necessary to know the area of a segment cut off by a chord between any two points of the parabolic arch and the above formula is not applicable. Moreover, there is considerable difficulty in determining accurately the length of the mid-ordinate of the chord.

The writer developed a formula several years ago which he used while estimating quantities in roadway construction. The formula is accurate and simple in its application. The area of a segment is a function of the length of the projection of the chord on the perpendicular to the axis of the parabola and the constant of the parabola.

Fig. 1 represents a parabola referred to two rectangular axes OX and OY. The equation of the parabola referred to these axes is

$$Y^2 = Kx \qquad (1)$$

The area of an element parrallel to the axis of the parabola between the Y-axis and the curve is

$$x\,dy = \frac{1}{K}\,Y^2\,dy$$

Area $BCOFF$ between the Y-axis, the curve and the two ordinates a and b is

$$\frac{1}{K}\int_{-b}^{a} Y^2\,dy = \frac{1}{K}\cdot\frac{Y^3}{3}\Big|_{-b}^{a} = \frac{1}{3K}(a^3 + b^3) =$$

$$= \frac{1}{3K}(a+b)(a^2 - ab + b^2)$$

Area of trapezoid $BCEF$ =

$$= \frac{1}{2K}(a+b)(a^2 + b^2)$$

Hence area of parabolic segment OCE =

$$= \frac{1}{2K}(a+b)(a^2 + b^2)$$

$$- \frac{1}{3K}(a+b)(a^2 - ab + b^2)$$

$$= \frac{1}{6K}(a+b)^3 \qquad (2)$$

For a span s and a rise r of a parabolic arch, the value of the constant K in equation (1) is $\frac{S^2}{4r}$.

Hence the formula for the area of the parabolic segment becomes

$$A = \frac{2}{3}\,\frac{r}{S^2}\,(a \pm b)^3$$

$a \pm b$ being used depending whether the ordinates a and b are on opposite sides or the same sides of the axis of the parabola respectively.

From Fig. 2 it is apparent that $a \pm b$ is the projection of the length of the chord of the segment on the perpendicular to the axis of the parabola. Using c for the length of the projection, the formula becomes

$$A = \frac{2}{3}\,\frac{r}{S^2}\,C^3 \qquad (3)$$

When c equals the span s of the parabolic arch, the area of the segment becomes

$$A = \frac{2}{3}\,rs$$

or the area equals two-thirds the product of the span by the rise, which provides a check on the accuracy of the formula.

As an example, let it be required to determine the area of a parabolic segment between points 21 ft. to the right and 9 ft. to the left of the crown of a roadway of 60 ft. span and 12 in. rise.

$C = 21 + 9 = 30$ ft.

$$A = \frac{2}{3} \times \frac{1}{(60)^2} \times (30)^3 = 5.0 \text{ sq. ft.}$$